

**BLACKSTONE RIVER BASIN  
MILLBURY, MASSACHUSETTS**

**DOROTHY POND DAM  
MA 00146**

# **PHASE I INSPECTION REPORT NATIONAL DAM INSPECTION PROGRAM**

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**DEPARTMENT OF THE ARMY  
NEW ENGLAND DIVISION, CORPS OF ENGINEERS  
WALTHAM, MASS. 02154**

**JULY 1978**

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20. ABSTRACT (Continue on reverse side if necessary and identify by block number) Dorothy Pond Dam is an earthfill dam with an upstream mortared masonry headwall. The dam has a maximum height of 13 feet and is approximately 200 feet long. The dam is considered to be in fair condition. There are several signs of distress which indicated potential hazard at this site. An inflow test flood of 2,850 cfs ( $\frac{1}{2}$ the PMF) will overtop the main dam by about 2.0 feet.		

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PHASE I INSPECTION REPORT

BRIEF ASSESSMENT

Identification No.: MA00146

Name of Dam: Dorothy Pond

Town: Millbury

County and State: Worcester County, Massachusetts

Stream: Tributary of Blackstone River

Date of Inspection: June 5, 1978

Dorothy Pond Dam which was constructed around 1825 is an earthfill dam with an upstream mortared masonry headwall. The dam has a maximum height of 13 feet and is approximately 200 feet long. The outlet conduit is a 24-inch diameter cast-iron pipe controlled by a rack and pinion operated wooden slide gate. The spillway, which is located 180 feet west from the dam, consists of a mortared stone paved channel that discharges into an earth channel.

A railroad embankment which is situated 500 feet upstream from the dam divides Dorothy Pond into two sections. A 4.5-foot by 5-foot box culvert transmits flow between the two sections.

There are no plans, specifications, or computations available from the Owner, County, State, or Town offices regarding the design, construction, or repairs of this dam except for a drawing showing proposed changes in the outlet mechanism and core wall, dated August 28, 1900.

Due to its age, Dorothy Pond Dam was neither designed nor constructed by current approved state-of-art methods. Based upon the visual inspection at the site, the lack of engineering data available, and limited operational or maintenance evidence, there are areas of concern which must be corrected to assure the continued performance of this dam. Generally, the dam is considered to be in fair condition. However, there are several visible signs of distress which indicate a

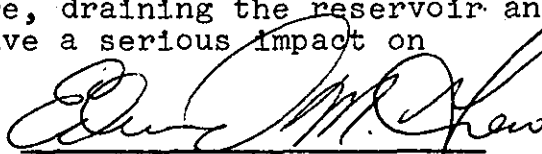


potential hazard at this site: slight-to-moderate seepage at the downstream toe of the dam, erosion on the upstream headwall and face of the dam, large trees on the dam crest, and accumulation of debris in the spillway channel. Between the Town and the dam there are two smaller dams, two factories, about 24 residences, and a power transmission line. However, in the event of dam failure few lives would be lost since the flood wave would be attenuated by the upstream railroad embankment and dissipated by the lower ponds, causing appreciable property damage but minimal loss of life.

Hydraulic analyses indicate that the existing spillway can discharge a flow of 264 cubic feet per second (cfs) at Elevation (El) 396 which is the top of the dam. An inflow test flood of 2,850 cfs (one-half of the probable maximum flood) will overtop the main dam by about 2.0 feet.

It is recommended that the Owner employ a qualified consultant to investigate the seepage at the downstream toe and to conduct a more detailed hydraulic and hydrologic study. It is further recommended that the Owner remove the trees on the dam crest and all debris from the spillway. Also, erosion of the headwall and upstream face should be repaired and riprap added to prevent continued deterioration of the dam.

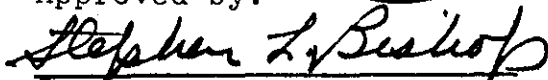
The above recommendations should be implemented within 1-2 years after receipt of the Phase I Inspection Report. An alternative to these recommendations would be draining the reservoir and breaching or removing the dam. However, it was reported that residents with frontage along the east edge of Dorothy Pond have shallow water supply wells which "dry out" at low pond levels. Therefore, draining the reservoir and breaching the dam could have a serious impact on these local residents.



Edward M. Greco, P.E.  
Project Manager  
Metcalf & Eddy, Inc.

Connecticut Registration  
No. 08365

Approved by:



Stephen L. Bishop, P.E.  
Vice President, Metcalf & Eddy, Inc.

Massachusetts Registration  
No. 19703



This Phase I Inspection Report on Dorothy Pond Dam has been reviewed by the undersigned Review Board members. In our opinion, the reported findings, conclusions, and recommendations are consistent with the Recommended Guidelines for Safety Inspection of Dams, and with good engineering judgment and practice, and is hereby submitted for approval.

CHARLES G. TIERSCH, Chairman  
Chief, Foundation and Materials Branch  
Engineering Division

FRED J. RAVENS, Jr., Member  
Chief, Design Branch  
Engineering Division

SAUL C. COOPER, Member  
Chief, Water Control Branch  
Engineering Division

APPROVAL RECOMMENDED:

JOE B. FRYAR  
Chief, Engineering Division

## PREFACE

This report is prepared under guidance contained in Recommended Guidelines for Safety Inspection of Dams, for a Phase I investigation. Copies of these guidelines may be obtained from the office of Chief of Engineers, Washington, D.C. 20314. The purpose of a Phase I Investigation is to identify expeditiously those dams which may pose hazards to human life or property. The assessment of the general condition of the dam is based upon available data and visual inspections. Detailed investigation, and analyses involving topographic mapping, subsurface investigations, testing, and detailed computational evaluations are beyond the scope of a Phase I investigation; however, the investigation is intended to identify any need for such studies.

In reviewing this report, it should be realized that the reported condition of the dam is based on observations of field conditions at the time of inspection along with data available to the inspection team. In cases where the reservoir was lowered or drained prior to inspection, such action, while improving the stability and safety of the dam, removes the normal load on the structure and may obscure certain conditions which might otherwise be detectable if inspected under the normal operating environment of the structure.

It is important to note that the condition of a dam depends on numerous and constantly changing internal and external conditions, and is evolutionary in nature. It would be incorrect to assume that the present condition of the dam will continue to represent the condition of the dam at some point in the future. Only through continued care and inspection can there be any chance that unsafe conditions be detected.

Phase I inspections are not intended to provide detailed hydrologic and hydraulic analyses. In accordance with the established Guidelines, the Spillway Test flood is based on the estimated "Probable Maximum Flood" for the region (greatest reasonably possible storm runoff), or fractions thereof. Because of the magnitude and rarity of such a storm event, a finding that a spillway will not pass the test flood should not be interpreted as necessarily posing a highly inadequate condition. The test flood provides a measure of relative spillway capacity and serves as an aid in determining the need for more detailed hydrologic and hydraulic studies, considering the size of the dam, its general condition and the downstream damage potential.

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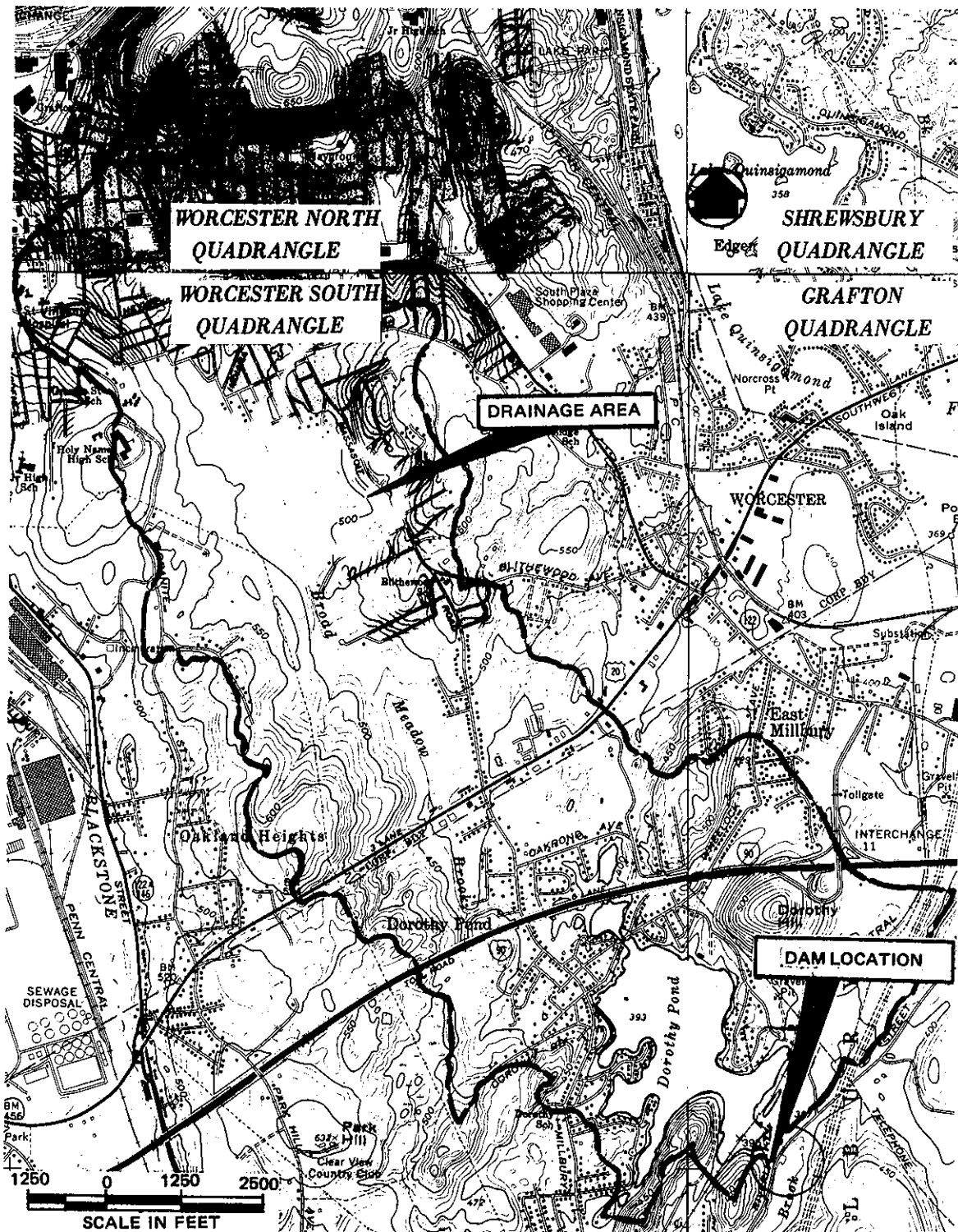
**OVERVIEW  
DOROTHY POND DAM  
MILLBURY, MASSACHUSETTS**



**VIEW OF UPSTREAM EMBANKMENT AND HEADWALL**

LOCATION AND DIRECTION OF  
PHOTOGRAPHS SHOWN ON FIGURES  
IN APPENDIX B





LOCATION MAP – DOROTHY POND DAM

NATIONAL DAM INSPECTION  
PROGRAM

PHASE I INSPECTION REPORT

DOROTHY POND

SECTION 1

PROJECT INFORMATION

1.1 General

- a. Authority. Public Law 92-367, August 8, 1972, authorized the Secretary of the Army, through the Corps of Engineers, to initiate a national program of dam inspection throughout the United States. The New England Division of the Corps of Engineers has been assigned the responsibility of supervising the inspection of dams within the New England Region. Metcalf & Eddy, Inc. has been retained by the New England Division to inspect and report on selected dams in the State of Massachusetts. Authorization and notice to proceed was issued to Metcalf & Eddy, Inc. under a letter of May 3, 1978, from Ralph T. Garver, Colonel, Corps of Engineers. Contract No. DACW 33-78-C-0306 has been assigned by the Corps of Engineers for this work.
- b. Purpose.
  - (1) Perform technical inspection and evaluation of non-Federal dams to identify conditions which threaten the public safety and thus permit correction in a timely manner by non-Federal interests.
  - (2) Encourage and assist the States to initiate quickly effective dam safety programs for non-Federal dams.
  - (3) To update, verify, and complete the National Inventory of Dams.



## 1.2 Description of Project

- a. Location. The dam is located in the Town of Millbury, Worcester County, Massachusetts, on Dorothy Brook, a tributary of the Blackstone River. See Location Map.
- b. Description of Dam and Appurtenances. Dorothy Pond Dam is a 13-foot high earthfill dam with mortared masonry walls at the intake and outlet (see Figures B-1 and B-2 in Appendix B). A 22-foot long by 14-foot high by 2.5-foot thick stone core wall, as shown in Figure B-3 in Appendix B, is about 13 feet from the outlet conduit headwall.

The dam embankment based on field measurements is approximately 200 feet long and is situated about 65 feet west of Riverlin Street. The dam crest is approximately 10 to 15 feet wide and upstream and downstream slopes are generally 2:1 (horizontal to vertical). The slopes are partially covered with grass, brush, and a few trees. Side slopes in the vicinity of the outlet conduit are flatter, nearly level with the headwall on the upstream slope and 3:1 on the downstream slope.

The outlet conduit is a 24-inch diameter pipe, apparently cast-iron, with invert El 383.8 at the outlet. The conduit flow is controlled by a wooden slide gate\* operated by a rack and pinion mechanism which is mounted on a 7.5-foot square, 8-inch thick concrete slab at the upstream headwall. The mechanism which is operable had been recently used. The upstream headwall around the intake is constructed of mortared masonry. It is 50 to 65 feet long, 2.5-feet thick at the top, and is 15-feet in height. The inlet to the conduit is 4.7 feet wide, 2.2 feet deep, and extends approximately 13 feet down to the invert of the conduit. The outlet headwall is constructed of mortared masonry and is

\*Information supplied by Mr. Joseph C. Cort.

20-feet long, 7-feet high, and 2-feet thick. Discharge flow passes into a small shallow stilling pool. At 34 feet downstream, flow passes through a 54-inch diameter corrugated metal culvert beneath Riverlin Street. The culvert invert is at El 384.7. Downstream of the culvert, water flows into a swampy area east of Riverlin Street.

The spillway is located about 180-feet southwest of the dam. The stone paved spillway channel is about 21-feet wide and 40-feet long. From the spillway, water flows into a natural stream bed about 360-feet long (see Figure B-1). The upper spillway crest is a 1-foot wide concrete weir at El 394.0. An 8.6-foot wide portion of this concrete has been breached to El 393.0 (see Figure B-2).

The spillway channel has mortared masonry sidewalls which are 2.1 to 2.4-feet high. The channel is covered with rock blocks, fallen wood, and miscellaneous debris. The downstream natural channel section is about 18-feet wide and 5-feet deep with steep side banks of sand and gravel. The water subsequently discharges into a 8.3 by 4.4-foot concrete box culvert beneath Riverlin Street. Invert elevation of the culvert is 386.3. Downstream of the culvert, the water enters a wide swampy area combining with the water from the outlet conduit.

Other features possibly regulating flow in Dorothy Pond are a series of three box culverts upstream of the dam. These are located where roads and a railroad cross the pond. The first is a 10-foot wide by 14-foot high concrete box culvert (invert El 393) beneath the Massachusetts Turnpike 5,000 feet northwest of the dam. The next is a 6-foot wide by 9.6-foot high concrete culvert (invert El 390.9) beneath MacArthur Road, 4,200 feet northwest of the dam. The closest restriction is an apparently abandoned railroad embankment located 500 feet northwest of the dam. It is a 4.5-foot wide by 5.2-foot high stone box culvert with an invert elevation of 387.8.

- c. Size Classification. Dorothy Pond Dam is classified in the "small" category since it has a maximum height of 13 feet and maximum storage capacity of about 800 acre-feet.
- d. Hazard Classification. The Town of Millbury is located approximately 1.3 miles downstream from the dam. Between the Town and the dam there are two smaller dams, two factories, about 24 residences, and a power transmission line. However, in the event of dam failure, few lives would be lost since the flood wave would be lessened because of the railroad embankment 500 feet upstream from the dam. Flooding of downstream areas would cause appreciable property damage and possibly endanger the downstream dams, causing further damage. Accordingly, the dam has been placed in the "significant" hazard category.
- e. Ownership. The dam is presently owned by Buck Brothers, Inc.; Box 192, Millbury, Massachusetts 01527. Mr. Cort (617-865-4482) granted permission to enter the property and inspect the dam.
- f. Operator. There are no known operators of the dam. Mr. Cort occasionally visits the dam since his office at Buck Brothers is located nearby.
- g. Purpose of Dam. The dam was originally constructed as a storage dam for the Blackstone Canal Corp. Subsequently, Buck Brothers, Inc. obtained ownership of the dam and used it as a storage dam for the generation of power elsewhere. Presently, water from the dam is used for cooling by Buck Brothers (located 3,500 feet downstream) in their manufacturing process. Also, the pond is used for recreation by local residents. Further, it was reported that residents with frontage along the east edge of Dorothy Pond have shallow water supply wells which "dry out" at low pond levels.
- h. Design and Construction History. The dam was originally constructed by the Blackstone

Canal Corp. in 1825.\* As mentioned, there are no plans, specifications, or computations available from the Owner, County, or State offices relative to the design, construction, or repairs of the original dam. Modifications to the original dam were proposed in 1900 by Buck Brothers (see Appendix B, Figure B-3). It was reported by Mr. Cort that the spillway elevation was raised approximately 18 inches. The date of this work is unknown. In 1955, Mr. Cort partially removed this raised spillway section because of upstream flooding. The slide gate for the outlet conduit was repaired in 1960 and subsequently replaced in 1970.

During the inspection of the dam, it was noted that some trees on the dam embankment had been cut down in the past.

- i. Normal Operating Procedures. There are no normal operating procedures at the dam. The only apparent outlet control for the dam is the 24-inch diameter outlet conduit. A 24-inch square wooden sluice gate operated by a rack and pinion mechanism controls flow into the outlet conduit. There is no lock on this mechanism. However, a long steel bar is necessary to operate the device. The outlet pipe is normally closed and is not periodically opened by Buck Bros., Inc.

The spillway for Dorothy Pond is ungated and flows are unrestricted though slight blockage is caused by existing debris.

### 1.3 Pertinent Data

- a. Drainage Area. The approximately 2,500-acre (3.91 square miles) drainage area above the dam consists of moderately developed, locally wooded, and gently rolling land. Discharge is to three unnamed small ponds located at 1,000 3,500 and 5,000 feet downstream. Subsequent flow is to the Blackstone River which is about 1.4 miles from Dorothy Pond.

\*Information supplied by Messrs. Wallace Lindquist and Joseph C. Cort.

- b. Discharge at Dam Site. Normal discharge above El 393 from the pond is through the spillway. It is approximately 2-feet high by 21-feet wide. It has a crest elevation of 394.0. There is a breached section in the center which has an elevation of 393 (See Figure B-2).

The spillway is about 40-feet long with mortared masonry sidewalls and loosely placed stones in the bottom. The channel slopes gently for about 40 feet and then discharges into a stream bed.

The stream bed is about 18-feet wide by 5-feet deep. It slopes gradually for about 360 feet, and then the discharge enters a concrete box culvert beneath Riverlin Street. The culvert is 4.4-feet by 8.3-feet in size with an invert elevation of 386.2. Downstream of the culvert is a wide swampy area.

The spillway can discharge an estimated 264 cfs at El 396 which is the top of the dam. An inflow test flood of 2,850 cfs (half of the probable maximum flood) will overtop the main dam by about 2.4 feet.

The maximum flood at the dam site is unknown; however, Mr. Cort at Buck Brothers, Inc. stated that neither the dam nor the railroad embankment were overtopped during the 1955 floods.

- c. Elevation (feet above MSL (Mean Sea Level)).  
A benchmark elevation of 394 at the upper section of the spillway crest was estimated from a U.S.G.S. topographic map.

- (1) Top dam - Main dam: 395.7 to 396.8.  
Railroad embankment (500 feet upstream)  
396.1
- (2) Maximum pool-design surcharge: 396
- (3) Full flood control pool: Not Applicable  
(N/A)
- (4) Recreation pool: 393.0

- (5) Spillway crest - Breached section  
(ungated): 393.0
- (6) Upstream portal invert diversion tunnel:  
N/A
- (7) Stream bed at centerline of dam: 383
- (8) Tailwater (outlet pipe closed): 386.6

d. Reservoir

- (1) Length of maximum pool: 6,000 feet
- (2) Length of recreation pool: 6,000 feet
- (3) Length of flood control pool: N/A

e. Storage (acre feet)

- (1) Recreation pool: 800 (approximate)
- (2) Flood control pool: N/A
- (3) Design surcharge: 300 at El 395.0  
(approximate)
- (4) Top of dam: 1,200 (approximate)

f. Reservoir Surface (acres) (It is assumed that an increase in elevation from 393 to 396 will not significantly increase the surface area of the pond.)

- (1) Top dam: 145
- (2) Maximum pool: 145
- (3) Flood-control pool: N/A
- (4) Recreation pool: 145
- (5) Spillway crest: 145

g. Dam

- (1) Type - earthfill dam with dry-stone masonry headwall

- (2) Length - 200 feet
- (3) Height - 13 feet
- (4) Top width: 10 feet
- (5) Side slopes - Upstream 2:1; downstream 2:1.
- (6) Zoning: Unknown
- (7) Impervious core: masonry core wall 20-feet long by 13-feet high by 2.5-feet thick centered at outlet conduit.
- (8) Cutoff: Unknown
- (9) Grout curtain: Unknown

1. Spillway

- (1) Type: Broad crest
- (2) Crest Length: 21 feet
- (3) Crest elevation: 393 MSL (breached section)  
394 MSL (unbreached)
- (4) Gates: None
- (5) Upstream Channel: None
- (6) Downstream Channel: 21-foot wide by 2.3-foot high spillway to stream channel 18-feet wide by 5-feet deep

- j. Regulating Outlets. The only apparent regulating outlet is a 24-inch diameter outlet conduit passing under the dam embankment. The flow is controlled by a wooden slide gate operated by a rack and pinion mechanism. Flow is discharged into a stilling pond. At 35 feet downstream of the outlet, flow enters a 54-inch diameter metal corrugated culvert beneath Riverlin Street. Downstream of the culvert, flow passes into a wide swampy area. The outlet conduit is not operated on a regular basis.

## SECTION 2

### ENGINEERING DATA

- 2.1 General. There are no plans, specifications, or computations available from the Owner, State, or County offices relative to the original dam built in 1825. However, one drawing dated August 28, 1900 is available from the Worcester County Commissioners Office showing a proposed core wall and proposed changes to the outlet works at Dorothy Pond (see Appendix, Figure B-3). The only other data used for this evaluation were visual observations during inspection, review of previous inspection reports, and conversations with the Owner and personnel from Town, State and County agencies.

The information available is such that the assessment of the condition of the dam must be based primarily on the visual inspection and past operational performance of the structure.

We acknowledge the assistance and cooperation of personnel of the Massachusetts Department of Public Works: Messrs. Willis Regan and Raymond Rochford, and of the Massachusetts Department of Environmental Quality Engineering, Division of Waterways: Messrs. John J. Hannon and Joseph Iagallo.

We acknowledge the cooperation and assistance of personnel from the Worcester County Engineer's Office: Messrs. John O'Toole, Joseph Brazauskas, and Mr. Wallace Lindquist - recently retired from county service. Also, we thank Mr. Christopher D. Baker, Millbury Town Engineer, for his assistance.

In addition, we thank Mr. Joseph C. Cort, Buck Bros., Inc. owner of the dam, who allowed the inspection of the dam and provided information on its history and operating characteristics.

- 2.2 Construction Records. There are no detailed construction records available except as included in Appendix B.



- 2.3 Operation Records. No operation records are available and there is no daily record kept of pool elevation or rainfall at the dam site.
- 2.4 Evaluation of Data. The data acquired are considered adequate for this Phase I Inspection and Evaluation.

SECTION 3  
VISUAL INSPECTION

3.1 Findings

- a. General. The Phase I inspection of the dam at Dorothy Pond was performed on June 5, 1978. A copy of the inspection report is included in Appendix A. Periodic inspections of this dam by others have been made since 1932. A listing of these inspections is in Appendix B. Two inspections were made in February 1972 and March 1976 by personnel from the Massachusetts Department of Public Works. Copies of their reports are included in Appendix B.
- b. Dam. The main dam is an earthfill dam with a mortared masonry headwall. Photographs in Appendix C show the dam and spillway. Slight seepage was noted at the downstream toe of the dam approximately 50 feet south and 90 feet north of the outlet. The seepage forms swampy areas adjoining the stilling pond. Flow is estimated to be less than 1 gpm, and the water is clear. "Moderate to heavy leakage at the downstream toe" was noted by the State during their March 5, 1976 inspection. No estimate of the quantity of flow or the location of the leakage was reported.

Erosion of the upstream face was observed at two locations along the headwall of the dam. These are washouts about 5-feet long and 2-feet deep located at the southern end and 10-feet south of the northern end of the headwall. The erosion at the northern end caused partial failure of the headwall. Also, it should be noted that there is no protecting riprap along the entire upstream face of the dam embankment.

Two oak trees about 30-inches in diameter, and smaller trees and brush are growing on both upstream and downstream embankment slopes. Older stumps are also visible which indicate previous efforts at clearing.

- c. Appurtenant Structures. The outlet structure is a 24-inch diameter cast-iron pipe surrounded by a mortared masonry headwall 7-feet high. The rim of the pipe is rusted, and the mortar in the headwall is deteriorated and missing in places. Downstream beneath Riverlin Street is a 54-inch diameter corrugated metal culvert with upstream and downstream headwalls. The headwalls of mortared masonry have deteriorated. The southern end of the upstream headwall has several missing stones apparently caused by surface runoff from Riverlin Street.

In the March 5, 1976 State inspection report it was noted that "the sluice gate doesn't seat properly and the timber portion of the gate stem will have to be replaced in a year or so." This condition was not apparent as the gate was not operated during the inspection.

The spillway channel is constructed of mortared masonry sidewalls. The bottom is partially lined with mortared riprap and partially covered with loose, randomly placed riprap. A few masonry blocks are missing out of place from the sidewalls and the mortar is deteriorated. The spillway channel is strewn with various debris such as fallen wood, tires, and dislocated rock blocks.

- d. Reservoir Area. The reservoir and drainage area is moderately populated: there are over 600 residences in the drainage area. The land is locally wooded and slopes range from about 5 to 30 percent.

As noted previously, there is a series of three box culverts upstream from the dam that may regulate flow at Dorothy Pond.

- e. Downstream Channel. The discharge from the spillway flows down a stream channel, through a concrete box culvert beneath Riverlin Street, and into a swampy area situated about 400 feet from the crest. The slope of the spillway channel is about 6 percent, and the slope of the stream channel is about 1

percent. The stream channel contains occasional fallen trees and has numerous overhanging trees. This debris would impede flow in the channel causing greater depths, but is sufficiently below the spillway level so that its discharge would not be affected. The box culvert is clear of obstructions and is in good condition.

From the culvert, the water flows to three small unnamed ponds and on to the Blackstone River.

- 3.2 Evaluation. The above findings indicate that the dam has several signs of distress that require attention. It is evident that the dam is not maintained and that deterioration will continue unless action is taken. Recommended measures to improve these conditions are stated in Section 7.

## SECTION 4

### OPERATING PROCEDURES

- 4.1 Procedures. There are no operating procedures at this dam. It was reported by the Owner that the outlet conduit is normally closed. It is not opened for releasing of water since there is sufficient storage in the lower ponds for their manufacturing needs. The outlet is apparently operated by persons other than the Owner, since the outlet was open during a site visit on May 19, 1978 but was closed during our inspection of June 5, 1978.
- 4.2 Maintenance of Dam. The dam is not regularly maintained, although some repairs as discussed previously have been done in the past.
- 4.3 Maintenance of Operating Facilities. The outlet conduit appears to be functional although it was reported by the State in their March 5, 1976 report that the "sluice gate doesn't seat properly and the timber portion of the gate stem will have to be replaced in a year or so." There is no locking mechanism on the rack and pinion controls for the slide gate. All that is needed is a long steel bar to operate the device.
- 4.4 Description of Any Warning System in Effect. There are no warning systems in effect at this dam.
- 4.5 Evaluation. There are no operating, maintenance, or warning systems in effect at Dorothy Pond Dam. This is undesirable considering the fact that it is in the "significant" hazard category. A program of periodic maintenance for this dam should be implemented. Further, a lock should be added to the outlet control.

SECTION 5  
HYDRAULIC/HYDROLOGIC

5.1 Evaluation of Features

- a. Design Data. The Probable Maximum Flood (PMF) maximum peak-flow rate was determined to be 1,460 cfs per square mile. This calculation is based on the average drainage area slope of 1.3 percent, the pond-plus-swamp-area to drainage-area ratio of 12 percent, as well as the U.S. Army Corps of Engineers' guide curves for Maximum Probable Flood Peak Flow Rates (dated December 1977). Applying one-half the PMF to the 3.91 square miles of drainage area results in a calculated peak flood flow of 2,850 cfs as the inflow test flood. By adjusting the inflow test flood for surcharge storage, the maximum discharge rate was established as 1,795 cfs, with a water surface at El 398.

Flow over the dam crest is predicted to be 1,172 cfs, while flow through the spillway section would be 623 cfs. The maximum head on the dam would be 2.0 feet at a discharge rate of approximately 5.9 cfs per foot of width. A flow having a 1.02-foot depth and a velocity of 5.8 feet per second would occur where flow becomes critical over the dam crest. A velocity of 5.8 feet per second could cause erosion of the dam and result in complete dam failure.

A 100-year frequency storm inflow was estimated to be 961 cfs. Adjusting this for storage would result in discharge of 440 cfs and a pond elevation of 396.6 and also produce flow over the dam.

Hydraulic analyses indicate that the existing spillway can discharge a flow of 264 cfs at El 396 which is the top of the dam.

- b. Experience Data. Experience records are not generally available for this dam. However,

Mr. Cort of Buck Brothers, Inc. stated that neither the dam nor the railroad embankment were overtopped during the 1955 floods.

- c. Visual Observations. The spillway consists of a 21-foot wide by 2.3 to 3.3-foot high, mortared stone masonry spillway which discharges into a 18-foot wide by 5-foot deep earth channel. The length of the spillway from the earth channel to the channel is about 40 feet. The orientation and location of the spillway is shown in Figure B-1.

The spillway crest had been partially lowered 12 inches in 1955 (See Figure B-2) because of upstream flooding. This indicates that small changes in pond elevation could cause localized flooding to residences near the shoreline.

- d. Overtopping Potential. Overtopping of the dam is expected under the inflow test flood of 2,850 cfs; as noted previously, however, the only available records on overtopping indicate that the dam was not overtopped during the 1955 floods.

In the event of overtopping, complete failure of the dam could occur. A flood wave due to dam failure would be attenuated by the upstream railroad embankment and dissipated by the lower ponds, causing appreciable property damage but minimal loss of life.

The Dorothy Pond Dam is part of a complex hydraulic system. The rectangular drainage area is crossed by several features which may constrict flow.

Drainage from the upper third of the area flows across a swamp with a man-made discharge channel which runs out between two natural highlands. Route 20 roughly divides the drainage area. The Massachusetts Turnpike separates the upper 70 percent of the area from the northern end of Dorothy Pond. Its culvert system would act to retard major flows to Dorothy Pond. About 800 feet south of the Turnpike, a 6-foot high by

9.6-foot wide culvert under MacArthur Road crosses the flow line in the pond. Finally, a railroad embankment crosses the pond about 500 feet northwest of the dam. The railroad embankment contains a stone box culvert 4.5-feet wide by 5-feet high.

Immediately downstream of the dam is the Riverlin Street embankment. The street which is about 2-feet lower than the dam crest would act as a secondary dam in case of failure of Dorothy Pond Dam. During high flows which could overtop the dam, the street embankment would cause high tailwater at the dam, in the order of 1.5 feet below the dam crest.

Downstream of Riverlin Street, discharge from Dorothy Pond passes through three impoundments before reaching the Blackstone River.

Based on the U.S.G.S. topographic maps, pond levels between El 390 and 400 may cause discharge at three locations. Two places are just upstream of the railroad, to the northeast and the southwest. The third is at the southerly most extension of the pond.



## SECTION 6

### STRUCTURAL STABILITY

#### 6.1 Evaluation of Structural Stability

- a. Visual Observations. The evaluation of the structural stability of Dorothy Pond Dam is based on the visual inspection on June 5, 1978. As discussed in Section 3, Visual Inspection, there were several visible signs of distress.

Based on these observations, Dorothy Pond Dam is a potential hazard. Static stability conditions are unsatisfactory and conventional factors of safety do not exist.

It is recommended that a more detailed investigation be initiated to evaluate the seepage at the downstream toe of the dam.

- b. Design and Construction Data. Discussions with the Owner, Town, County, and State personnel indicate that there are no plans, specifications, or computations relative to the design, construction, or repairs of this dam other than the one drawing dated August 28, 1900 which shows proposed changes to the outlet works and a proposed core wall (see Figure B-3). Information on the type, shear strength, and permeability of the soil and/or rock materials of the dam embankment does not appear to exist.

It was learned that this dam was built in 1825, probably of local soil or rock materials. As noted above, Figure B-3, shows a proposed stone masonry core wall. This core wall is shown to be 22-feet long by 14-feet high by 2.5-feet thick and is located 13 feet from the outlet conduit headwall. Since the dam is about 200 feet long, the core wall only extends for about 10 percent of the total length.

- c. Operating Records. There is no evidence of instrumentation of any type in Dorothy Pond Dam, and there is nothing to indicate that any instrumentation was ever installed in this dam. The performance of this dam under prior loading can only be inferred by previous records and physical evidence at the site.
- d. Post-Construction Changes. There are no as-built drawings for Dorothy Pond Dam. Modifications to the original dam were proposed by Buck Brothers, Inc. in 1900. (See Figure B-3.) There is no as-built information relative to these changes. It was reported by Mr. Cort that the spillway elevation was raised about 18 inches at some unknown time. In 1955, Mr. Cort partially removed this raised spillway section. The slide gate for the outlet conduit was repaired in 1960 and subsequently replaced in 1970.
- e. Seismic Stability. This dam is located in Seismic Zone 2. Since static stability conditions are unsatisfactory, the dam is particularly vulnerable in the event of an earthquake.

## SECTION 7

### ASSESSMENT, RECOMMENDATIONS, AND REMEDIAL MEASURES

#### 7.1 Dam Assessment

- a. Condition. Due to its age, Dorothy Pond Dam was neither designed nor constructed according to current approved state-of-art methods. Based upon the visual inspection at the site, the limited engineering data available, and little operational or maintenance evidence, there are areas of concern which must be corrected to assure the continued performance of this dam. Generally, the dam is considered to be in fair condition. However, there were several signs of distress observed at the site: slight to moderate seepage at the downstream toe of the dam, erosion on the upstream headwall and face of the dam, large trees on the dam crest and an accumulation of debris in the spillway channel.

Hydraulic analyses indicate that the existing spillway can discharge a flow of 264 cfs at El 396, which is the top of the dam. An in-flow test flood of 1,795 cfs will overtop the main dam by about 2.0 feet. Since previous records at this site indicate the dam was not overtopped in the 1955 floods because of the upstream attenuating effect of the railroad embankment, it is unlikely that this is a serious potential hazard. Pond elevations above EL 390 may cause flow at three locations as noted in Section 5.1.d.

- b. Adequacy of Information. The information available is such that the assessment of the condition of the dam must be based primarily on the visual inspection and the past operational performance of the structure.
- c. Urgency. The recommendations outlined below should be implemented within 1 to 2 years after receipt of the Phase I Inspection Report.

- d. Need for Additional Information. Additional investigations to further assess the adequacy of the dam and appurtenant structures are outlined below in 7.2 Recommendations.

7.2 Recommendations. In view of the concerns on the continued performance of this dam, it is recommended that the Owner employ a qualified consultant to:

- a. evaluate the dam stability and the seepage at the downstream toe;
- b. conduct a more detailed hydraulic and hydrologic investigation at the site and determine the need to increase spillway capacity.

The recommendations on repairs and maintenance procedures are stated below under 7.3 Remedial Measures.

### 7.3 Remedial Measures

- a. Alternatives. An alternative to the recommendations above and the maintenance procedures itemized below would be to drain the reservoir and breach or remove the dam. However, it was reported that residents with frontage along the east edge of Dorothy Pond have shallow water supply wells which "dry out" at low pond levels. Therefore, draining the reservoir and breaching the dam could have a serious impact on those residents.
- b. Operations and Maintenance Procedures. The dam and appurtenant structures are not adequately maintained. It is recommended that the Owner accomplish the following items:
  - (1) remove the trees on the dam and clear all debris from the spillway;
  - (2) repair erosion of the upstream headwall and dam face, and install riprap to prevent continued deterioration of the dam;
  - (3) institute a definite plan for surveillance and a warning system during periods of unusually heavy rains and/or runoff

- (4) implement a systematic program of inspection and maintenance. As a minimum the inspection program should consist of a monthly inspection of the dam and appurtenances and be supplemented by additional inspections during severe storms. All repairs and maintenance should be undertaken in accordance with all applicable State regulations.

## APPENDIX A

Periodic Inspection Checklist

Page

A-1

# PERIODIC INSPECTION

## PARTY ORGANIZATION

PROJECT Dorothy Pond

DATE 6/5/78

TIME 8:00 am → 6:00 pm

WEATHER partly cloudy, showers, 70°

W.S. ELEV. 393.3 U.S. 386.6 D.N.S.

Assumed benchmark elevation 394  
upper section of spillway

### PARTY:

- |                         |           |
|-------------------------|-----------|
| 1. <u>Ed Greco</u>      | 6. _____  |
| 2. <u>Carol Sweet</u>   | 7. _____  |
| 3. <u>Susan Pierce</u>  | 8. _____  |
| 4. <u>Lyle Branagan</u> | 9. _____  |
| 5. _____                | 10. _____ |

### PROJECT FEATURE

### INSPECTED BY

### REMARKS

- |                    |                      |  |
|--------------------|----------------------|--|
| 1. <u>Dam</u>      | <u>Ed Greco</u>      |  |
| 2. <u>Spillway</u> | <u>Lyle Branagan</u> |  |
| 3. _____           |                      |  |
| 4. _____           |                      |  |
| 5. _____           |                      |  |
| 6. _____           |                      |  |
| 7. _____           |                      |  |
| 8. _____           |                      |  |
| 9. _____           |                      |  |
| 10. _____          |                      |  |

# PERIODIC INSPECTION CHECK LIST

PROJECT Dorothy Pond DATE 6/5/78  
 PROJECT FEATURE Dam Site NAME Ed Greco  
 DISCIPLINE Geotechnical NAME \_\_\_\_\_

AREA EVALUATED	CONDITIONS
<u>DAM EMBANKMENT</u>	
Crest Elevation	<u>varies from 395.7 to 396.8</u>
Current Pool Elevation	<u>393.3</u>
Maximum Impoundment to Date	<u>Unknown</u>
Surface Cracks	<u>none visible</u>
Pavement Condition	<u>n/a</u>
Movement or Settlement of Crest	<u>irregular crest</u>
Lateral Movement	<u>none visible</u>
Vertical Alignment	<u>headwall vertical</u>
Horizontal Alignment	<u>relatively straight</u>
Condition at Abutment and at Concrete Structures	<u>dam crest lowest at abutments</u>
Indications of Movement of Structural Items on Slopes	<u>none</u>
Trespassing on Slopes	<u>2 large trees growing on crest, one on left abutment, dead stumps on d/s face,*</u>
Sloughing or Erosion of Slopes or Abutments	<u>Erosion of u/s slope adjacent to inlet headwall (possible 5 feet)</u>
Rock Slope Protection - Riprap Failures	<u>see above. Also, few stones missing from headwall. No other riprap on u/s face</u>
Unusual Movement or Cracking at or near Toes	<u>none visible</u>
Unusual Embankment or Downstream Seepage	<u>45 ft SW of outlet centerline, less than 1 gpm (very slight); slight seepage in left abutment area</u>
Piping or Boils	<u>none visible</u>
Foundation Drainage Features	<u>no known underdrains</u>
Toe Drains	<u>unknown</u>
Instrumentation System	<u>none visible</u>

Footpath, animal burrows



## PERIODIC INSPECTION CHECK LIST

PROJECT Dorothy Pond DATE 6/5/78  
 PROJECT FEATURE Railroad Embankment NAME Ed Greco  
 DISCIPLINE Geotechnical NAME \_\_\_\_\_

AREA EVALUATED	CONDITION
<u>DIKE EMBANKMENT</u>	RR embankment separates upper and lower Dorothy Pond
Crest Elevation	396.1
Current Pool Elevation	393.3
Maximum Impoundment to Date	unknown
Surface Cracks	none visible
Pavement Condition	RR tracks, rotted ties
Movement or Settlement of Crest	none visible
Lateral Movement	none
Vertical Alignment	culvert headwalls vertical
Horizontal Alignment	straight
Condition at Abutment <del>and at Concrete Structures</del>	no apparent settlement
Indications of Movement of Structural Items on Slopes	none visible
Trespassing on Slopes	boat launch; recreational path
Sloughing or Erosion of Slopes or Abutments	u/s slope shows some erosion
Rock Slope Protection - Riprap Failures	riprap irregular; sloughing
Unusual Movement or Cracking at or near Toes	none visible
Unusual Embankment or Downstream Seepage	none visible
Piping or Boils	none visible
Foundation Drainage Features	unknown
Toe Drains	unknown
Instrumentation System	none visible

# PERIODIC INSPECTION CHECK LIST

PROJECT Dorothy Pond DATE 6/5/78  
 PROJECT FEATURE Outlet Works NAME Ed Greco  
 DISCIPLINE Geotechnical NAME \_\_\_\_\_

AREA EVALUATED	CONDITION
<u>OUTLET WORKS - INTAKE CHANNEL AND INTAKE STRUCTURE</u>	
a. Approach Channel	None
Slope Conditions	n/a
Bottom Conditions	"
Rock Slides or Falls	"
Log Boom	"
Debris	"
Condition of Concrete Lining	"
Drains or Weep Holes	"
b. Intake Structure	stone masonry head wall with concrete mortared joints *
Condition of Concrete	Fair
Stop Logs and Slots	none visible

\* submerged intake with rack and pinion slide gate control

# PERIODIC INSPECTION CHECK LIST

PROJECT Dorothy Pond DATE 6/5/78  
 PROJECT FEATURE Outlet Works NAME Ed Greco  
 DISCIPLINE Geotechnical NAME \_\_\_\_\_

AREA EVALUATED	CONDITION
<u>OUTLET WORKS - TRANSITION AND CONDUIT</u>	
General Condition of Concrete	n/a
Rust or Staining on Concrete	"
Spalling	"
Erosion or Cavitation	"
Cracking	"
Alignment of Monoliths	"
Alignment of Joints	"
Numbering of Monoliths	"

Inlet and outlet submerged;  
 24-inch diameter cast iron  
 pipe, outlet end rusted

# PERIODIC INSPECTION CHECK LIST

PROJECT Dorothy Pond

DATE 6/5/78

PROJECT FEATURE Outlet Works

NAME Ed Greco

DISCIPLINE Geotechnical

NAME \_\_\_\_\_

AREA EVALUATED	CONDITION
<u>OUTLET WORKS - OUTLET STRUCTURE AND OUTLET CHANNEL</u>	
General Condition of Concrete	stone masonry headwall, mortared; condition fair
Rust or Staining	none
Spalling	minor spalling of mortar
Erosion or Cavitation	none visible
Visible Reinforcing	none
Any Seepage or Efflorescence	none
Condition at Joints	mortar is spalled
Drain Holes	none
Channel	small stilling pool, randomly placed stones
Loose Rock or Trees Over- hanging Channel	loose rock sloughed in from D/S culvert headwall
Condition of Discharge Channel	outlet discharges into small stilling pool, then into 54-inch corrugated metal culvert under Riverlin street. Headwall for culvert is stone masonry with recently mortared stones above crown of pipe. West section of wall has fallen down from surface erosion from road.

# PERIODIC INSPECTION CHECK LIST

PROJECT Dorothy Pond

DATE 6/5/78

PROJECT FEATURE Spillway

NAME Ed Greco

DISCIPLINE Geotechnical

NAME \_\_\_\_\_

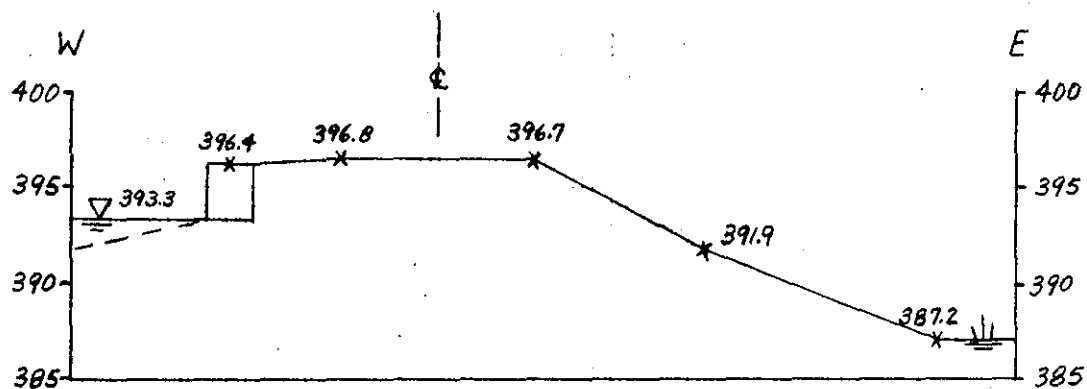
AREA EVALUATED	CONDITION
<u>OUTLET WORKS - SPILLWAY WEIR, APPROACH AND DISCHARGE CHANNELS</u>	
a. Approach Channel	None
General Condition	n/a
Loose Rock Overhanging Channel	"
Trees Overhanging Channel	"
Floor of Approach Channel	"
b. Weir and Training Walls	
General Condition of Concrete	concrete breached on weir; remnants in poor condition
Rust or Staining	none
Spalling	mortar joints deteriorating - washed out in places
Any Visible Reinforcing	none
Any Seepage or Efflorescence	none
Drain Holes	none
c. Discharge Channel	
General Condition	cluttered with dislodged rock blocks trees, and debris
Loose Rock Overhanging Channel	none
Trees Overhanging Channel	50-75' downstream along earth channel - brush and small trees (6" - 1' dia.)
Floor of Channel	rock blocks near spillway - downstream bed is gravel and cobbles
Other Obstructions	branches, litter

## APPENDIX B

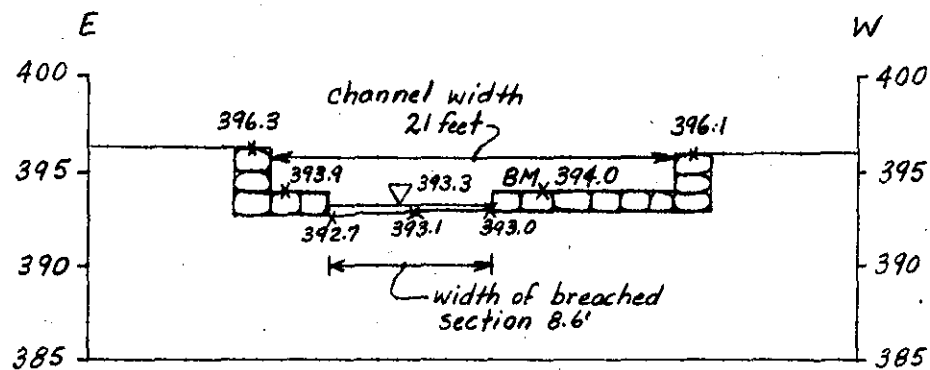
### DAM PLAN AND PAST INSPECTION REPORTS

	<u>Page</u>
Dam Plan - Figure B-1	B-1
Dam and Spillway Sections - Figure B-2	B-2
Plan of Dam dated August 28, 1900 - Figure B-3	In Pocket
Previous Inspections (Partial Listing)	B-4
Inspection Report by Massachusetts Department of Public Works (February 1, 1972)	B-6
Inspection Report by Massachusetts Department of Public Works (March 5, 1976)	B-7



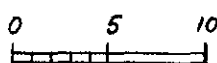


DAM SECTION 1-1



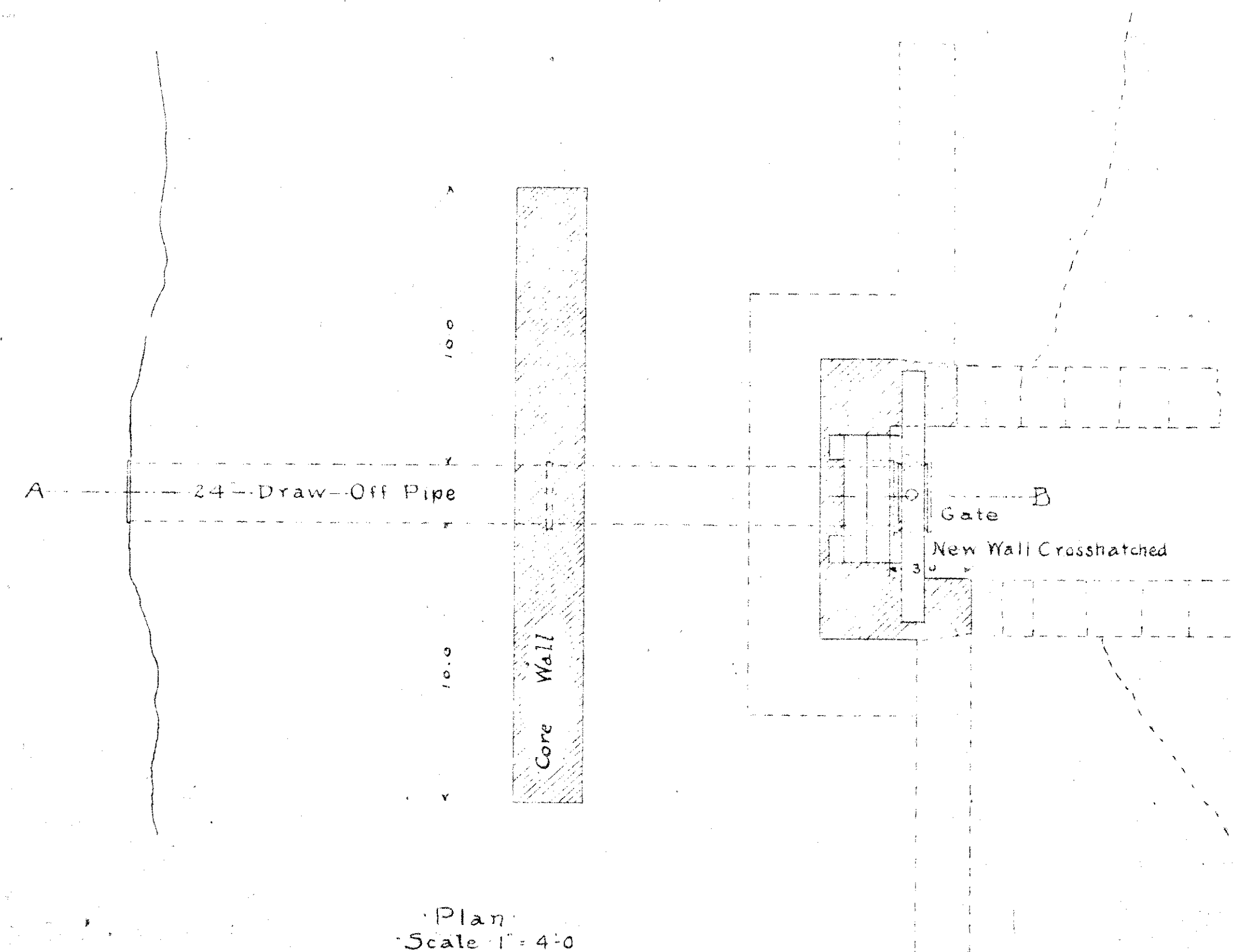
SPILLWAY SECTION 2-2

Scale in Feet



Note: For locations of sections, see Figure B-1.

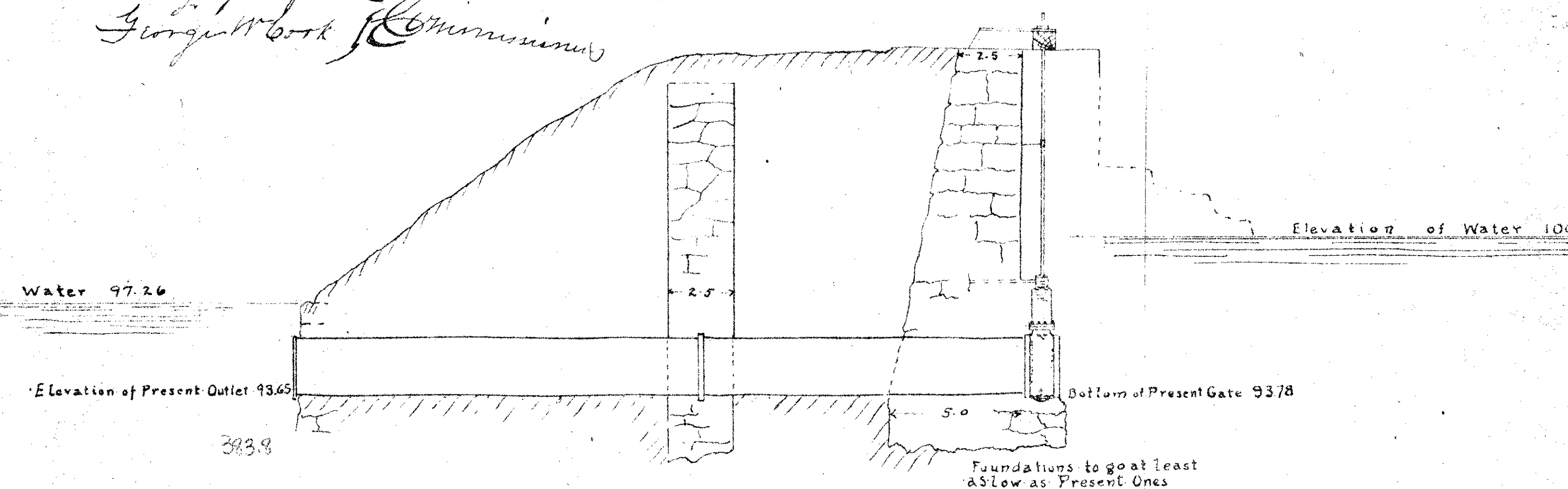




Plan  
Scale 1" = 4'-0"

Plans of Proposed Changes in Outlet  
Dorothy Pond Dam  
Buck Bros Millbury Mass.  
Engineer Aug 27 1900

Aug 28 1900  
Approved  
Commissioner  
Henry L. Taft  
George W. Cook  
Commissioner



Section A-B

WORCESTER COUNTY COMMISSIONERS WORCESTER COUNTY ENGINEERING DEPARTMENT PLAN OF DAM AT DOROTHY POND MILLBURY, MASS. FOR BUCK BROTHERS AS FILED AND APPROVED BY THE <b>COUNTY COMMISSIONERS</b> AUG. 28, 1900 JUNE MEETING DOCKET 320 SCALES AS NOTED	
TRACED BY: <i>E. J. Grover</i> 3-4-36 TRACING CHECKED BY: <i>L. O. Marden</i> 3-6-36	DAM NO. 30-08
<i>L. O. Marden</i> COUNTY ENGINEER	
<i>Wm. C. Brown</i> Clerk	

TOWN OR CITY <i>Millbury</i>	DECREE NO. <i>320</i>	PLAN NO. <i>(H to M)</i>	DAM NO. <i>30 08</i>
LOCATION <i>Near center</i>	NATURAL POND + STORAGE POND		C. C. DOCKET NO. <i>186</i>

DESCRIPTION OF DAM	DESCRIPTION OF RESERVOIR & WATERSHED
Type <i>Earthen - Rubble</i> Length Height Thickness top " bottom Downstream Slope Upstream " Length of Spillway Size of Gates <i>24" Draw off pipe c.i.</i> Location of Gates " " " " <i>same</i> Flashboards used Width Flashboards or Gates <i>24"</i> Dam designed by <i>Outlet by Chas. A. Allen C.E.</i> " constructed by Year constructed	Name of Main Stream <i>Dorothy Pond</i> " " any other Streams Length of Watershed Width " " Is Watershed Cultivated Percent in Forests Steepness of Slope Kind of Soil No. of Acres in Watershed <i>4.45 sq. M.</i> " " " " Reservoir Length of Reservoir Width " " Max Flow Cu. Ft. per Sec. Head or Flashboards-Low Water " " " " -High "
GENERAL REMARKS	GENERAL REMARKS
<i>Buck Bros. - Specifications</i> <i>C.C. Records - Vol. 29</i> <i>P. 180.</i> <i>Aug. 28, 1900</i> <i>Inspected: Sept. 29, 1932 - L.D.M.</i> " : <i>May 20, 1937 - K.M.F.</i> " : <i>Oct. 19, 1938 - "</i> " : <i>Dec. 12, 1940 - L.H.J.</i> " : <i>Dec. 10, 1942 - J.A.H.</i>	<i>(Docket #320. Meeting June 1900 Filed Aug. 28, 1900.</i> <i>Traced by: E.S. Grover, March 4, 1936.</i> <i>Checked by: L.O. Marden, March 6, 1936.</i> <i>Attested by: William C. Bowen, C. of C.</i> <i>Charles A. Allen, Eng. Aug. 27, 1900</i> <i>Inspected: Dec. 13, 1945 - W.O. Lindquist</i>  <div style="text-align: right;"><i>(OVER)</i></div>

PREVIOUS INSPECTIONS (PARTIAL LISTING)

COPY OF INSPECTION CARD ON FILE AT THE MASSACHUSETTS  
DEPARTMENT OF PUBLIC WORKS, DISTRICT OFFICE, WORCESTER.

Vol. 8, Pg 470 - Dec 1825 accepted and recorded - for Blackstone Canal Corp -  
at outlet of Dorset Pond - on land of Jacob Dodge & Daniel Rice.

inspected Aug. 15, 1960. by W.O.L. & C.I.C.

02.1

(111011)

21-11-186-02

## INSPECTION REPORT &amp; DATA FOR DAMS

Owner: BUCK BROOKS, INC.  
 His Address: RIVERLIN ST., MILBURY  
 Function of Dam: NATURAL POND & SPILLWAY

Dam No. 21-11-186-02  
 Town: MILBURY  
 Stream: DOLOTHY POND  
 Pond: DOLOTHY POND  
 Date: 2/1/72  
 By: \_\_\_\_\_

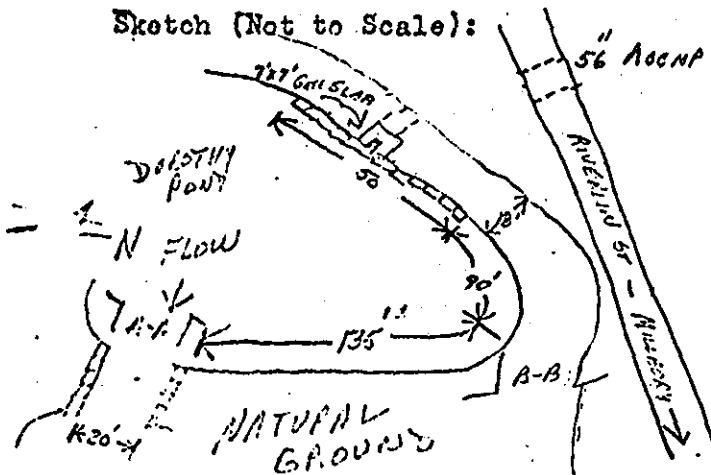
Location & Access: 1/2 MI. NE. ON ROUTE 56  
1/2 MI. N. OF ROUTE 56  
 USGS Quad. Grafton Lat. 42° 12' 35" Long. 71° 44' 40"  
 Drain. Ar.: 445 Sq. Mi. Ponds: ac. Res. Dam: \_\_\_\_\_  
 Character of D.A.: \_\_\_\_\_

CONDITION RATING  
 Structural: Good  
 Hydraulic: Good  
 General: Good  
 PRIORITY: Normal

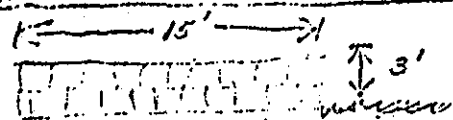
Estimated  
 Discharge: \_\_\_\_\_  
 Capacity: \_\_\_\_\_

General Description of Dam and Discharge Control: 24" DRAIN OFF PIPE  
24" OF TERRAZZO AT GATES, EARTHEN RUBBER, SPILLWAY 5' WIDE  
AT WESTERN END OF DAM MADE OF STONE MASONRY, 5-6 TREES  
18"-30" ON DAM. SIZE OF GATES NOT SEEN BECAUSE OF ICE.

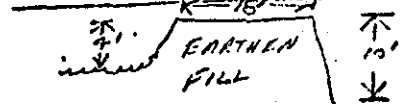
Sketch (Not to Scale):



A-A SIDEVIEW SPILLWAY



B-B DAM END VIEW



Remarks and Recommendations:

LARGE OLD TREES SHOULD BE CUT DOWN.

Date

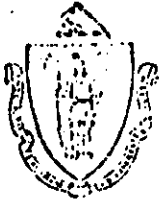
2/1/72

By

E. NICHOLSON  
R. NICHOLSON

Comment

Dam No. 21-11-186-02



# *The Commonwealth of Massachusetts*

EXECUTIVE OFFICE OF ENVIRONMENTAL AFFAIRS  
DEPARTMENT OF ENVIRONMENTAL QUALITY ENGR.  
DIVISION OF WATERWAYS

100 Nashua Street, Boston 02114

October 19, 1976

Buck Brothers, Inc.  
Riverlin Street  
Millbury, Massachusetts

RE: Inspection Dam #3-14-186-08

Gentlemen:

On March 5, 1976, an Engineer from the Massachusetts Department of Public Works made a visual inspection of the above dam. Our records indicate the owner to be Buck Brothers, Inc. If this information is incorrect will you please notify this office.

The inspection was made in accordance with the provisions of Chapter 253 of the Massachusetts General Laws as amended (Dams-Safety Act). Chapter 706 of the Acts of 1975 transferred the jurisdiction of the so-called "Dams Safety Program" to the Commissioner of the Department of Environmental Quality Engineering.

The results of the inspection indicate that this dam is safe; however the following conditions were noted that require attention:


This inspection was requested by the Millbury Board of Selectmen. The Town is considering acquisition of the dam.

1. By acquiring title to the dam, the Town assumes responsibility for upkeep and/or restoration.
2. The Town would be liable for damage to life and property downstream in the unlikely event of dam failure.

(OVER)

We call these conditions to your attention before they become serious and more expensive to correct. With any correspondence please include the number of the Dam as indicated above.

Very truly yours,

  
JOHN G. HANNON, P.E.  
CHIEF ENGINEER

*Wine*  
A.MC:rlb  
cc: Board of Selectmen, Millbury

3. Repairs now required would be expensive. Rip rap is needed on 125+ linear feet of the upstream face. Heavy growth of trees and brush on the downstream face should be removed. The sluice gate doesn't sit properly and the timber portion of the gate stem will have to be replaced in a year or so. There is heavy leakage flowing through the downstream toe--the only cutoff shown by County records is a 22' horizontal x 12' vertical stone concrete wall at the sluice within the dam, and 35'+ of grouted, cut fieldstone wall at the upstream face (at the gate).
4. A review of County records on this dam leads me to conclude that the leakage occurs whenever the pool elevation reaches spillway invert elevation and becomes insignificant when pool elevation drops a few feet below invert elevation. Since there are residences with gravity wells adjacent to the pond, the lower pond elevation may be unsatisfactory.
5. The deficiencies noted are significant. A consultant should be retained to prepare plans, specifications and an estimate for restoration.



*The Commonwealth of Massachusetts*  
*Department of Public Works*

DISTRICT #3 OFFICE  
403 BELMONT STREET, WORCESTER MA 01604

March 11, 1976

John T. Hannon, P.E.  
Chief Engineer  
Division of Waterways  
Department of Environmental Quality Engineering  
100 Nashua St.  
Boston, Mass.

SUBJECT: MILLBURY  
Dam No. 3-11-186-08  
INSPECTION REPORT

RECEIVED MAR 12 1976

*F.N.M.*  
*Dam Section*

Dear Sir:

Enclosed for your consideration is a dam description and  
an inspection report for the above dam.

Very truly yours,

*John D. Lyons*  
John D. Lyons, P.E.  
District Highway Engineer

WAR/je  
C - ROR  
WAR

# DESCRIPTION OF DAM

DISTRICT 3

Submitted by W. Regan Dam No. 3-14-186-08

Date 3/10/76 City/Town Millbury

Name of Dam Dorothy Pond

1. Location: Topo Sheet No. 24 A (GRAFTON QUAD)

Provide 8 1/2" x 11" in clear copy of topo map with location of Dam clearly indicated.

2. Year built: 1853 <sup>Prior To</sup> Year/s of subsequent repairs 1900.... 1959... 1970....

3. Purpose of Dam: Water Supply \_\_\_\_\_ Recreational (Present Usage)  
Irrigation \_\_\_\_\_ Other (Originally Mill Storage)

4. Drainage Area: 4.45 sq. mi. \_\_\_\_\_ acres

5. Normal Ponding Area: 145 ± acres; Ave. depth N/A

Impoundments: N/A gals.; N/A acre ft.

6. No. and type of dwellings located adjacent to pond or reservoir  
\_\_\_\_\_ i.e. summer homes, etc. >100 Perm. Res.

7. Dimensions of Dam: Length 260' ± Max. Height 13' ±

Slopes: Upstream Face Vert. Stone Wall & 1:1 earth emb. (1:1 Slope due To Wave Action)  
Downstream Face 2 1/4:1 T. 2:1

Width across top 18' ±

8. Classification of Dam by Material:

Earth ✓ Conc. Masonry ✓ Stone Masonry ✓

Timber \_\_\_\_\_ Rockfill \_\_\_\_\_ Other \_\_\_\_\_

9. A. Description of present land usage downstream of dam:

80 % <sup>Residential</sup> rural; 20 % <sup>Light Industry</sup> urban.

B. Is there a storage area or flood plain downstream of dam which could accomodate the impoundment in the event of a complete dam failure? yes \_\_\_\_\_ no ✓



10. Risk to life and property in event of complete failure.

See Note  
Below

No. of people Loss of life is A Remote Possibility  
 No. of homes 10 ±  
 No. of Businesses 4  
 No. of industries — Type —  
 No. of utilities — Type —  
 Railroads —  
 Other dams 186-6, 7, 7.1  
 Other At least 2 Road Crossings, 1 X-Country Hi-Ten line.

11. Attach Sketch of dam to this form showing section and plan on 8½" x 11" sheet.

12. How to Locate: S.E. Bound on Rte 122 (GRAFTON),  
 Turn Rt. onto Deerholm St. Deerholm St  
 becomes Riverlin St after crossing Millbury T.L.  
 Dam is Rt. of Riverlin St. 1.3 ± mi. beyond T.L.

Note (10): Impact of failure discharge would be  
 Attenuated by the following Circumstances:

① Discharge would, after some time, become  
 limited by the hydraulic Capacity of the R.R. Culvert  
 (5½' x 4½' Stone box) 500' ± upstream of the  
 dam.

② The elevation of the Riverlin Rd. Pavement  
 is only 6" ± below present Pond Elevation.  
 This present Pond Elev. appears to be  
 Untypically high. Therefore under most conditions  
 the Riverlin Rd Embankment would function  
 as a Supplementary dam.

# INSPECTION REPORT - DAMS AND RESERVOIRS

1. Location: City/Town Millbury Dam No. 3-14-186-08

Name of Dam DOROTHY POND Inspected by Regan, RIZKALLA

Date of Inspection 3/5/76

2. Owner/s: per: Assessors \_\_\_\_\_ Prev. Inspection ☒

Reg. of Deeds \_\_\_\_\_ Pers. Contact \_\_\_\_\_

1. Buck Brothers Inc., Riverlin St, Millbury, MASS.  
Name \_\_\_\_\_ St. & No. \_\_\_\_\_ City/Town State Tel. No. \_\_\_\_\_

2. \_\_\_\_\_  
Name \_\_\_\_\_ St. & No. \_\_\_\_\_ City/Town State Tel. No. \_\_\_\_\_

3. \_\_\_\_\_  
Name \_\_\_\_\_ St. & No. \_\_\_\_\_ City/Town State Tel. No. \_\_\_\_\_

3. Caretaker (if any) e.g. superintendent, plant manager, appointed by absentee owner, appointed by multi owners.

Name: \_\_\_\_\_ St. & No.: \_\_\_\_\_  
City/Town: \_\_\_\_\_ State: \_\_\_\_\_ Tel.No.: \_\_\_\_\_

4. No. of Pictures taken \_\_\_\_\_

5. Degree of Hazard: (if dam should fail completely)\*

1. Minor \_\_\_\_\_ 2. Moderate ☒  
3. Severe \_\_\_\_\_ 4. Disastrous \_\_\_\_\_

\* This rating may change as land use changes (future development)

6. Outlet Control: Automatic \_\_\_\_\_ Manual ☒

Operative ☒ yes; \_\_\_\_\_ No.

Comments: Wooden Gate Stem with Steel RACK & Steel strip Attached may have to be repaired or replaced in a year or so Steel SALVAGEABLE. Timber in fair to poor Condition.

7. Upstream Face of Dam: Condition:

1. Good \_\_\_\_\_ 2. Minor Repairs \_\_\_\_\_  
3. Major Repairs ☒ 4. Urgent Repairs \_\_\_\_\_

Comments: RIP. RAP has to be Placed on Approx.

100' linear feet 2 140' OF The upstream Face. 2 WASHOUTS  
(Slope Failures) To be backfilled with  
Suitable material (loc. @ Ends of Vertical  
Upstream Walls). Both WASHOUTS Approx.  
5' x 4' x 3' depth

8. Downstream Face of Dam:

Condition: 1. Good \_\_\_\_\_ 2. Minor Repairs \_\_\_\_\_  
3. Major Repairs ☒ 4. Urgent Repairs \_\_\_\_\_

Comments: *Moderate to heavy leakage noted @ downstream toe (No boils noted). Heavy growth of trees & brush on downstream face.*

9. Emergency Spillway:

Condition: 1. Good \_\_\_\_\_ 2. Minor Repairs ☒  
3. Major Repairs \_\_\_\_\_ 4. Urgent Repairs \_\_\_\_\_

Comments: *5 TON Voids could be keyed with smaller stones and/or grouted. Some channel side slope erosion noted at the downstream end of the spillway.*

10. Water Level at time of inspection: 3.8 ± ft. above \_\_\_\_\_ below ☒  
top of dam ☒ principal spillway \_\_\_\_\_  
other 2 1/2" ± Above Invert @ Ctr. of emergency spillway.

11. Summary of Deficiencies Noted:

Growth (Trees and Brush) on Embankment ☒

Animal Burrows and Washouts ☒ (See sketch)

Damage to slopes or top of dam " " "

Cracked or Damaged Masonry UPSTREAM WALL collapsed @ extremities

Evidence of Seepage ☒

Evidence of Piping No boils yet noted, but if leakage continues at present rate, boils will very probably appear.

Erosion ☒

Leaks ☒ Moderate to heavy through d.s. toe

Trash and/or debris impeding flow \_\_\_\_\_

Clogged or blocked spillway \_\_\_\_\_

Other Gate can't be seated properly - some water flowing through sluice.

## 12. Remarks &amp; Recommendations: (Fully Explain)

This inspection was requested by the Millbury board of Selectmen. The town is considering acquisition of the dam so that it can control the water level.

The owner should receive the standard letter summarizing deficiencies noted and the town should be advised of the following:

- ① By acquiring title to the dam, the town assumes responsibility for upkeep and/or restoration.
- ② The town would be liable for damage to life and property downstream in the unlikely event of a dam failure.

- ③ Repairs now required would be expensive.

RIP RAP is needed on 125± linear feet of the upstream face. Heavy growth of trees & brush on the d.s. face should be removed. The sluice gate doesn't seat properly and the timber portion of the gate stem will have to be replaced in a year or so. There is heavy leakage flowing through the d.s. toe.

The only cutoff shown by county records is a 22' horiz. x 12'± vert. stone core wall at the sluice and within the dam and 35'± of grouted cut fieldstone wall at the upstream face (at the gate).

## 13. Overall Condition:

(Cont. on Sheet 3A)

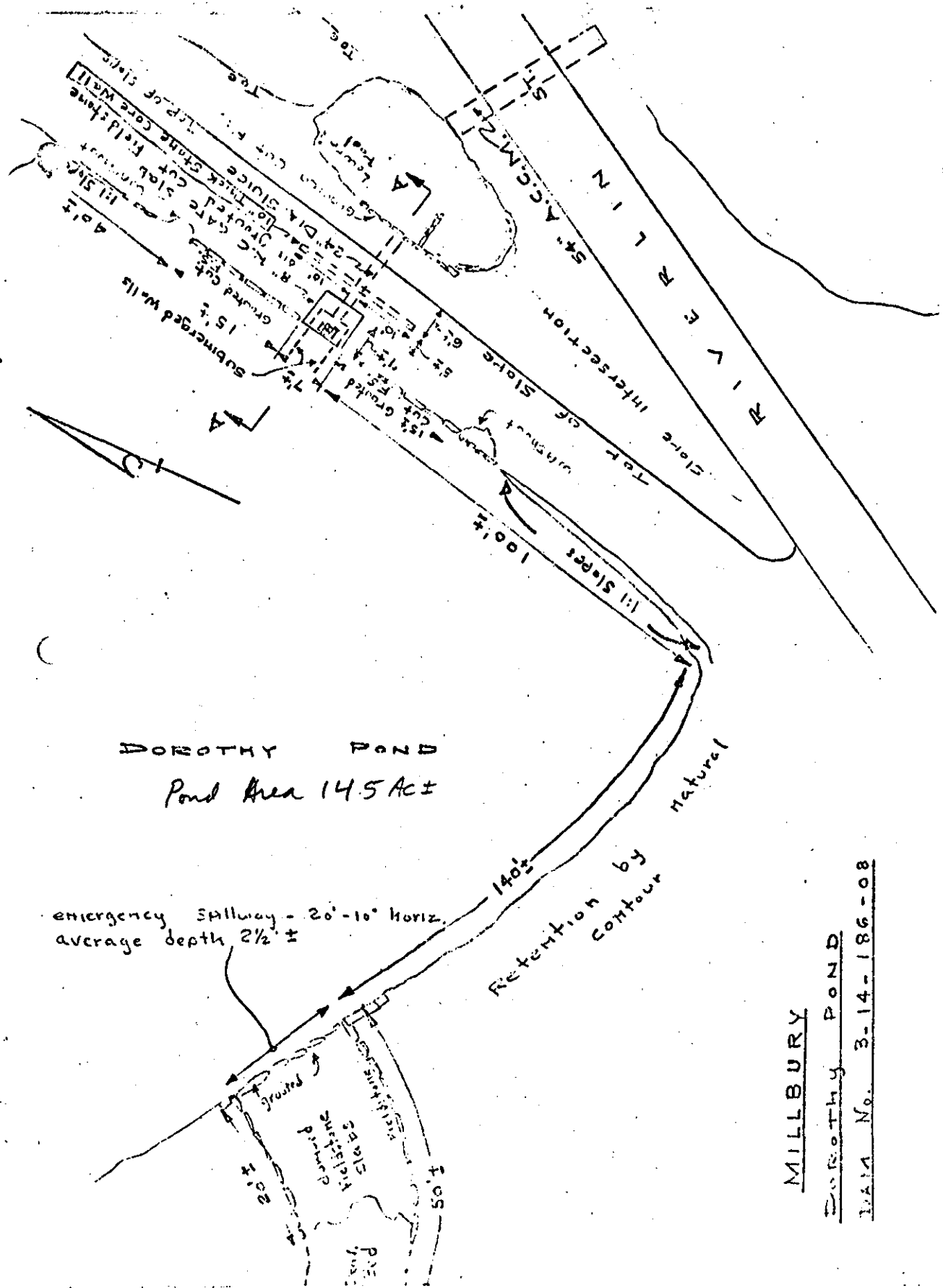
1. Safe \_\_\_\_\_
2. Minor repairs needed \_\_\_\_\_
3. Conditionally safe - major repairs needed ☒ \_\_\_\_\_
4. Unsafe \_\_\_\_\_
5. Reservoir impoundment no longer exists (explain)  
Recommend removal from inspection list \_\_\_\_\_

Sheet 3A

- ④ A review of County records on this dam leads me to conclude that leakage occurs whenever Pool elev. reaches Spillway Invert elevation and becomes insignificant when Pool elev. drops a few feet below Invert Elev.

Since there are residences with Gravity wells adjacent to the Pond, the lower Pond Elev. may be unsatisfactory.

- ⑤ The deficiencies noted are significant; a Consultant should be retained to prepare a P.S. & E. for restoration.



DOROTHY POND

Pond Area 14.5 Ac±

emergency spillway - 20' - 10' horiz.  
average depth 2 1/2 "

Retention by  
contour

Natural

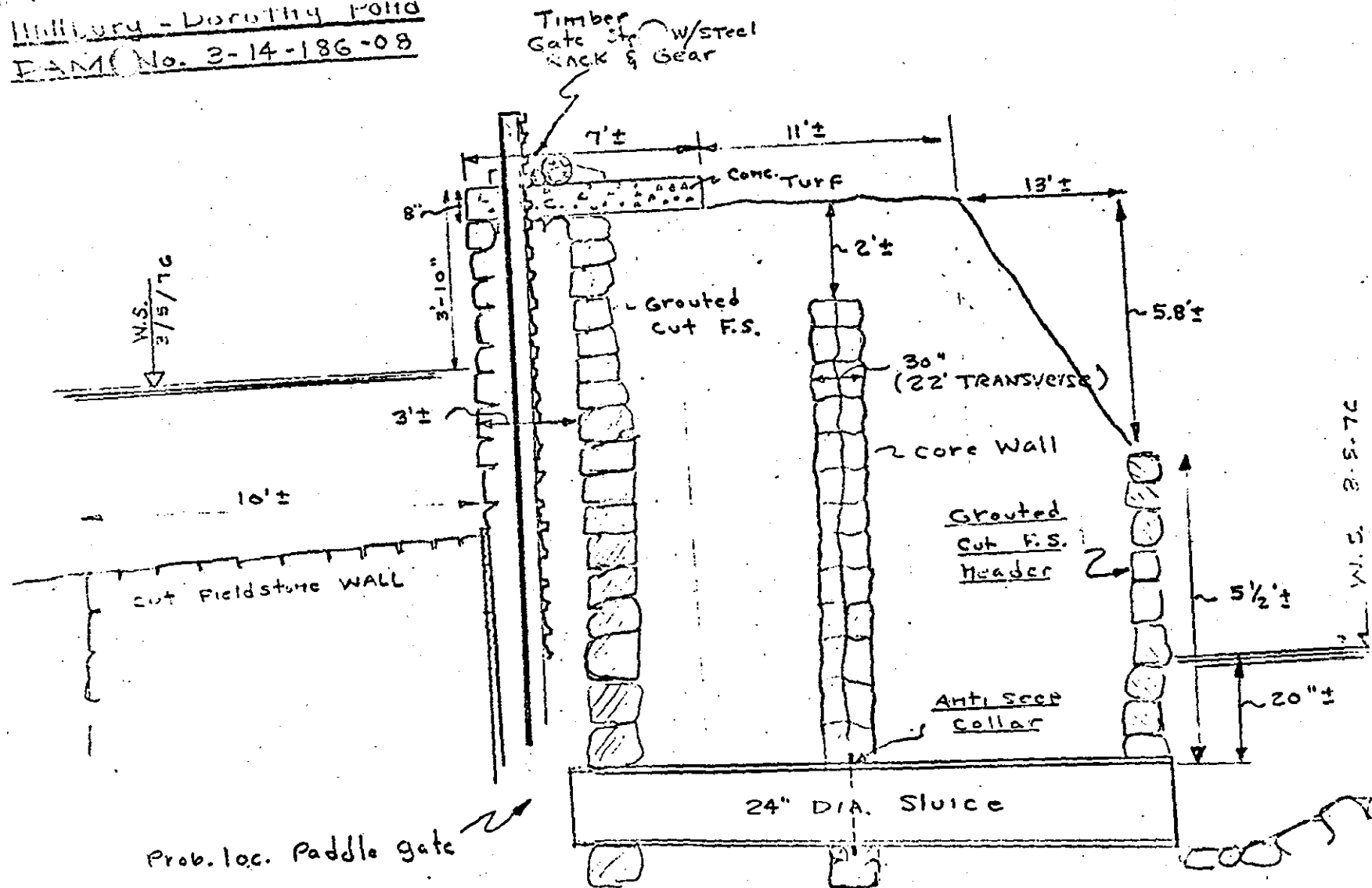
MILLBURY

Dorothy Pond

DRAIN No. 3-14-186-08

Hillbury - Dorothy Pond  
DAM No. 3-14-186-08

B-17



SECTION A-A

(Not To Scale)

APPENDIX C  
PHOTOGRAPHS





**NO. 1 - SOUTHWEST VIEW OF TOP OF DAM**



**NO. 2 - VIEW OF OUTLET AND STILLING POOL**





**NO. 3 - VIEW OF SPILLWAY**



**NO. 4 - VIEW OF RAILROAD EMBANKMENT, LOOKING UPSTREAM**

APPENDIX D

HYDROLOGIC AND  
HYDRAULIC COMPUTATIONS



## I Est of Peak Flow Rates

Trib Area is 3.91 mi<sup>2</sup> to Dorothy Pond of 0.23 mi<sup>2</sup> in area. Trib Area is  $\pm$  20000' long by a little over 5000' wide for most of the length. A natural topographic constriction 12000 ft north west of the dam, culverts under Rte 20, culverts under Interstate 90 and a railroad embankment  $\pm$  500 ft north east of the dam appear to influence the hydraulics of area runoff.

Generally runoff is toward the central stream, with a slope of 4% to 6%. The central stream is about 14000 ft somewhat winding above the pond, with a drop of  $460 - 393 = 67$  ft. The average slope is  $\pm 0.5\%$  and the swamp + pond area is estimated @  $0.46$  mi<sup>2</sup> or 12% of D. A

Total "Que" Drop =  $150' + 67 = 217'$ ,  $L = 14000 + 2500 = 16500$

Total "Ave" Drop =  $150' + 67' = 217'$ ,  $L = 14,000 + 2,500 = 16,500$

Say Ave Slope = 1.37. w/ 12% Ponds & Swamps

Using The C of E. Maximum Probable Flood - Peak Flow Rates (M.P.F. - P.F.R.) curves, as expanded by data on the Leesville Dam and aided by slope & % pond + swamp comparisons with S.C.S. sources, a P.F.R. for this dam site is taken as:

Ave. P.F.R. = 1460 cfs/mi<sup>2</sup>

$$\text{Tot. P.F.R.} = 1460 \times 3.91 = 5700 \text{ cf}$$
$$\frac{1}{2} \text{Tot. P.F.R.} = 2850 \text{ cfs} = \text{Inflow Test Flood}$$

## II Est. Pond Storage (Above Elev. 393)

Core Dam, Area = 0.23 mi<sup>2</sup> - Assume no area increase w/ Depth  
Core R.R. Embankment, Area = 0.22 mi<sup>2</sup> " " " "

[illegible]

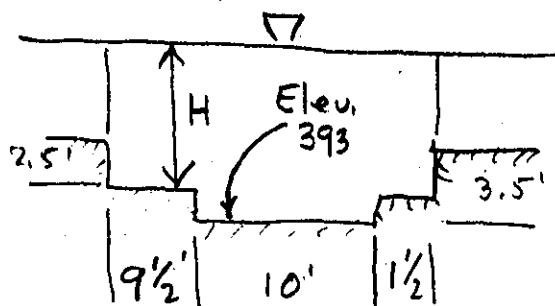
### III Dam Disch. - Storage vs Elev.

Dam is  $200' \pm$  long with a slightly off center  $24" \phi$  sluice pipe. The sluice is controlled by wooden slide gate w/ Rack and Gear positioning device. About  $30'$  below the sluice pipe discharge is carried by a  $54"$  ACCM culvert under Riverlin Street. The street level is about 3 to 4 feet below the dam crest. Max. (ent. controlled) sluice flow is 65 c.f.s. under a head of  $15'$ . Higher heads produce spillway discharge. The sluice flow is too minor to be considered further.

The dam is protected by a spillway separated from the dam structure. It consists of a  $21'$  foot wide uncontrolled broad weir. Originally it had a crest  $2' \pm$  below the side walls. Later a central section was broken & rocks removed for  $10' \pm$  feet for a crest  $3' \pm$  below the side walls. Approach flow would have no valuable vel. head since the spillway is generally  $\perp$  to the approach flow.

#### (A) Spillway Discharge (Assume Broad Crest)

$$Q = 3.12 (L) H^{3/2}$$

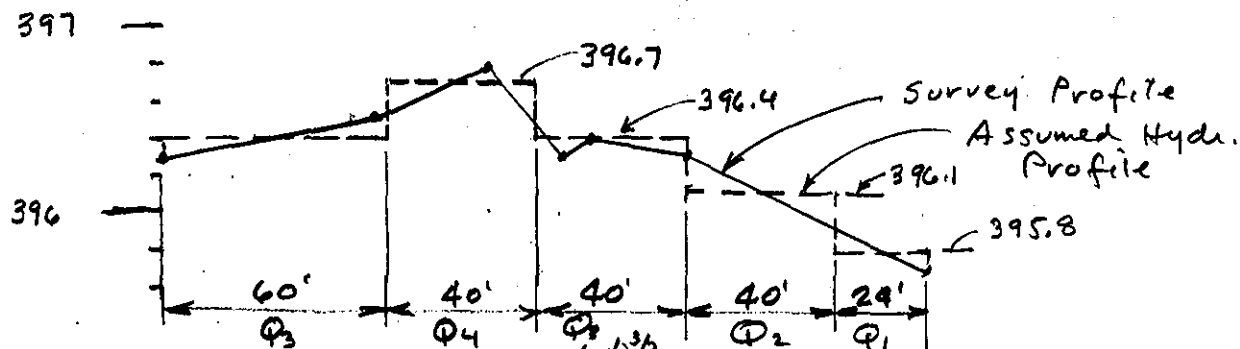


$$Q = 3.12 (11) H^{3/2} + 3.12 (10) (H+1)^{3/2}$$

$$Q = 34.3 H^{3/2} + 31.2 (H+1)^{3/2}$$

H	2.5	3	3.5	4.0	4.5	5.0	5.5	6.0	1.0	1.5	2.0
Spillway Q	340	428	522	623	730	842	960	1082	122'	186	259
W.S. Elev.	396.5	397	397.5	398	398.5	399	399.5	400	395.0	395.5	396.0

## (B) Dam Crest Discharge



$$Q = 2.55(H')^{3/2}$$

$$Q_1 = 61.2(H'_1)^{3/2} - H'_1 = 0 \text{ W.S.} = 395.8$$

$$Q_2 = 102(H'_2)^{3/2} - H'_2 = H'_1 - 0.3'$$

$$Q_3 = 255(H'_3)^{3/2} - H'_3 = H'_1 - 0.6'$$

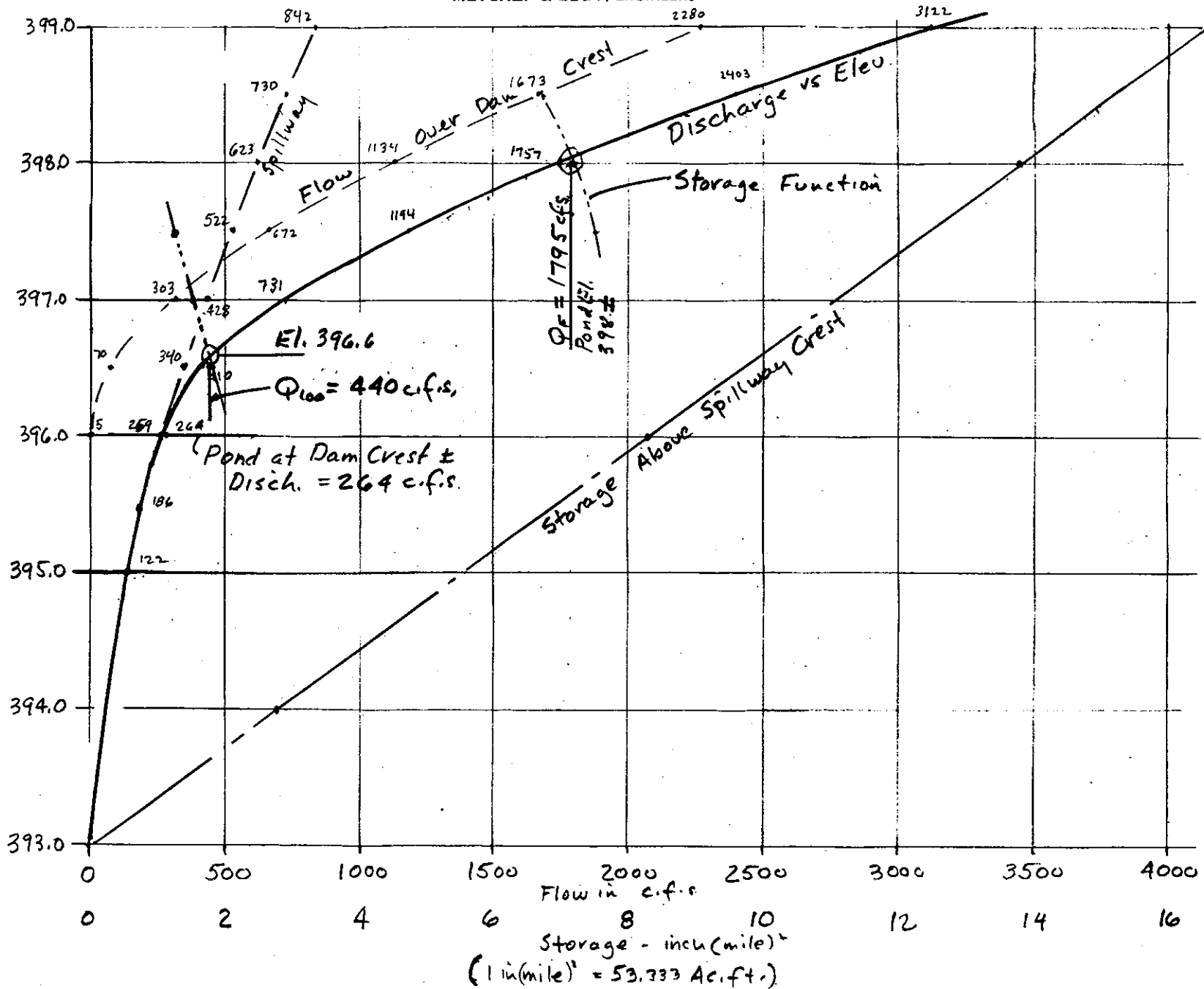
$$Q_4 = 102(H'_4)^{3/2} - H'_4 = H'_1 - 0.9'$$

Elev.	396.0	396.5	397.0	397.5	398.0	398.5	399.0
H'	0.2	0.7	1.2	1.7	2.2	2.7	3.2
Q cfs	5	70	303	672	1134	1673	2280

## (C) Storage (Above Elev. 393.0)

Area = 0.23 mi<sup>2</sup> = 147 Acres.

Elev.	Storage in. mile <sup>2</sup> in. on T.A.	Elev.	Storage in. mile <sup>2</sup> in. on T.A. (S)	Storage Functions F <sub>T</sub>	F <sub>100</sub>
393.0	0	396.0	8.3	2.1	
393.5	1.4	396.5	9.7	2.5	451
394.0	2.8	397.0	11.0	2.8	390
394.5	4.1	397.5	12.4	3.2	1890
395.0	5.5	398.0	13.8	3.5	1800
395.5	6.9	398.5	15.2	3.9	1684



D-4

Project	Nat. (New) Dam Insp. Prog.	Acct. No.	5864	Page	4 D of 11
Subject	Worcester Ma Area	Compd. By	LEB	Date	6/12/78
Detail	Dorothy Pond Dam	CK'd. By	EMG	Date	6/15/78
					Rev. 7/19/78 LEB

[Gen. Reference: "Open Channel Hydraulics" - Ven Te Chow]

**(I) Broad Crested Spillway -  $Q_s = CLH^{1.5}$  [Ref. pp 360-362]**

$$C = 3.27 + 0.4 \frac{H}{h} ; L = L' - 0.1NH$$

$H$  = Physical Water Head on CREST ( $h_v$  not included)

$h$  = Weir Height,  $L'$  = Measured Crest Length

Assumptions

For Floods or Peak Flows,  $\frac{H}{h} \approx 0.5 \therefore C = 3.47$

$$L = 90\% L'$$

$$\therefore Q_s = 3.12 L' H^{3/2}$$



**(II) Flow over Crest of Dam -  $q_c = 3.475 \left[ \frac{y}{y+h'} \right]^{1/2} (H')^{3/2}$  [Ref. pp 52-3]**

$q_c$  = Disch. / ft. of width

$H' \neq h'$  as defined above;  $y = h' + H'$

Assumptions

For Floods (flow over dam crest)

$$H' = \frac{1}{6} h' \text{ [note } h' \approx h + H \text{ in Item (I) above]}$$

$$\therefore y = \frac{7}{6} h' \neq \left[ \frac{y}{y+h'} \right]^{1/2} = \left[ \frac{7/6 h'}{13/6 h'} \right]^{1/2} = 0.734$$

$$\therefore q_c = 2.55 (H')^{3/2}$$

Apply to Crest in steps where levels are roughly const.



#### ④ Adjusting Peak Flow by Storage Function

$$Q_F = 2850 \left(1 - \frac{S_F}{9.5}\right)$$

$S$  = inches on Trib. Area equivalent to storage @ elev.

$S_F$  = Final storage inches when  $Q_{out}$  is balanced

$Q_F$  = Final  $Q_{out}$  - det. by plot on Disch. vs. Elev. Curve using storage function

Storage Function:  $Q_{out} = 2850 - 300S = F_{TF}$

See pgs D-3 & D-4

From Plot final Peak Outflow = 1795 cfs.  
 with Pond @ Elev. 398.0 ±

#### Critical Flow over Crest

Pond Elev. 398.0

Low Pt Crest 395.7

Max Depth 2.3'

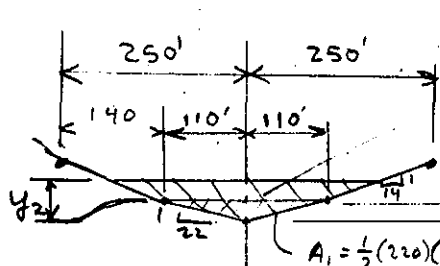
$$q = 2.55 (2.3)^{1.5} = 8.89 \text{ cfs/ft.}$$

$$y_{crit.} = 1.35' ; V_{crit.} = 6.6 \text{ fps}$$

## V Downstream Flood Due to Dam Break

Dorothy Brook connects Dorothy Pond Dam and the Blackstone river at a junction about 3000 feet East of the center of Millbury, Ma. The Brook is about 7500 feet long, passes through 3 small impoundments and has a drop of  $387 - 347 = 40$  feet. A number of houses, industries and a school lie in the flood way of Dorothy Brook. Failure of Dorothy Pond Dam may cause failure of the lower impoundment.

A typical X-Section Selected for the Dam Failure analysis is as follows.



$$S = \frac{40}{7500} = 0.53\%$$

$$S^{1/2} = 0.073$$

Due to Trees, Bldgs, etc  
 Use  $n = 0.10$

$P = \text{width}$   
 $P_2 = 220 + 28y_2$

$A_1 = \frac{1}{2}(220)(5) = 550 \text{ ft}^2$   
 $A_1 = 22y_1^2$   
 $P_1 = 44y_1$

$V = \frac{1.49}{.10} R^{2/3} (0.073) = 1.0877 R^{2/3}$

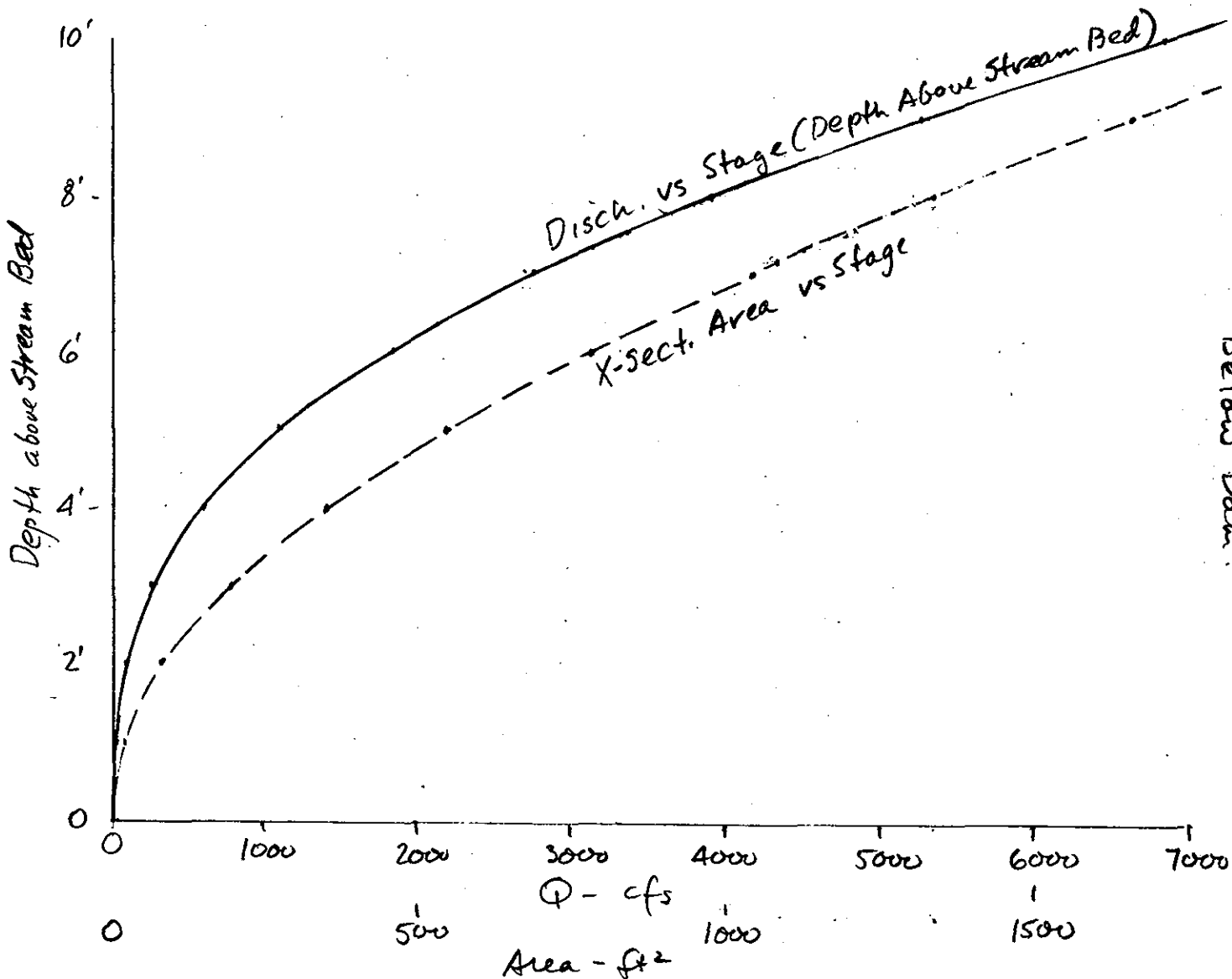
For Depth Above 5' ( $y = y_2 + 5'$ )

For Depth below 5'

$y_2$	0	1'	2'	3'	4'	5'	$y_1$	1'	2'	3'	4'
$A_2$	550	784	1046	1336	1654	2000	→	22	88	198	352
$P_2$	220	248	276	304	332	360	→	44	88	132	176
$R^{2/3}$	1.84	2.154	2.431	2.68	2.917	3.137	→	0.630	1.0	1.310	1.587
$V_2$	2.00	2.343	2.644	2.92	3.173	3.412	→	0.685	1.088	1.425	1.727
$Q_2$	1101	1837	2766	3899	5248	6824	→	15	96	282	608

Project Net (non-F) Dam Insp. Program Acct. No. 5864 Page 82 of 11  
 Subject Worcester Ma. Area Comp'd. By LEB Date 5/30/78  
 Detail Dorothy Pond Dam Ck'd. By EMG Date 6/16/78

Stage Disch. of Dorothy Creek  
Below Dam



## V (Cont.)

### ① For Full Pond (no R.R. Embankment Effect)

W.S. @ Dam - Elev. 398.0 ;  $S = 800 + 5(1.23)640 = 1536 \text{ Ac. ft.}$

$Y_0 = 398 - 387 = 11.0$  ;  $W_p = 0.4(149) = 59.6'$

$Q_{p1} = \frac{8}{27} (59.6) \sqrt{32.2} (11.0)^{3/2} = 3655 \text{ cfs}$  , Stage 1 = 7.8' ,  $A_1 = 1275 \text{ ft}^2$

### ① For 7500' Reach Vol. 1 = 1275(7500) = 220 Ac. ft. < $\frac{1}{2} S$

Trial  $Q_{p2} = 3655(1 - \frac{220}{1536}) = 3132 \text{ cfs}$  ; Stage 2 = 7.3' ,  $A_2 = 1125 \text{ ft}^2$

Vol. 2 = 7500(1125) = 194 Ac. ft. ; Ave Vol. =  $(194 + 220) \frac{1}{2} = 207$

$Q_{p2} = 3655(1 - \frac{207}{1536}) = 3160 \text{ cfs}$  . - Ave Stage = 7.4'

$T = 24 \frac{S}{Q_p} = 24 \frac{1536}{3160} = 11.7 \text{ hours}$  ; Max  $\bar{V} = \frac{3160}{1150} = 2.75 \text{ fps}$

At 2.75 fps, it takes 45 min. to reach Blackstone River - 7500' ± downstream.

## VI 100 year Storm Flow

100 yr. freq. - 6 hr. rain = 4.7 in. (Tech Paper No. 40)

Infiltration taken @ 0.3 in/hr. = 1.8 "

2.9 in for Runoff.

$(\frac{2.9}{19.0 - 1.8})(5700) = 961 \text{ cfs}$  as est 100 yr storm peak inflow

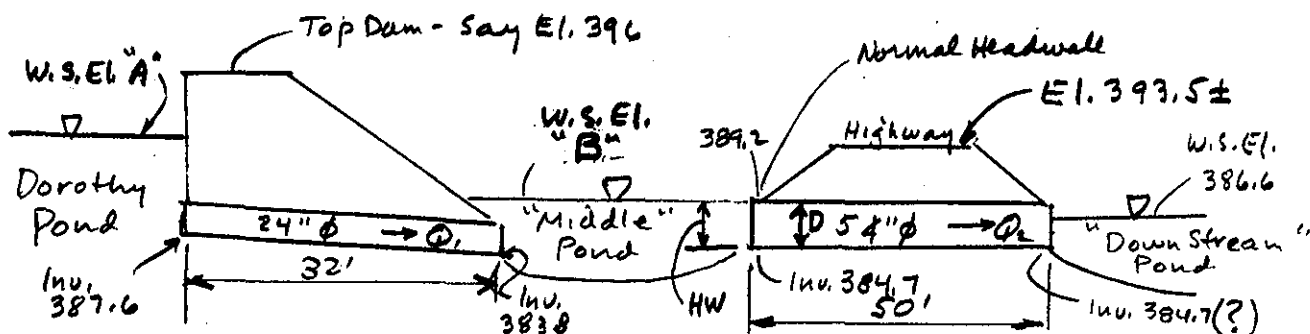
Storage Function =  $F_{100} = 961(1 - \frac{S_F}{4.7}) = 961 - 204 S_F$

Based on Disch. Plot vs Storage Function Plot

give  $Q_{100 \text{ out}} = 410 \text{ cfs}$  @ Pond Elev. 396.85

## VI Misc. Considerations

### A Outlet Pipe Capacity



1 - Flow thru 54"  $\phi$  Culvert Assume Dn Str. Pond Const. @ Elev. 387, for Peak  $Q$   
 Top Culv.  $384.7 + 4.5 = 389.2' > 386.6$ ;  $\Delta \text{Elev} = 2.6'$   
 Assume Inlet Control (Fig 4-20, Hbk of Steel Drain & Hwy Const. Prod)

HW/D	0.9	1.0	1.1	1.2	1.3	1.4	1.5	1.7	1.9	2.0	2.2	2.4
$Q$	81	95	110	120	130	141	151	170	180	192	195	210
Middle Pond Elev.	388.8	389.2	389.6	390.1	390.5	391.0	391.4	392.3	393.2	393.7	394.6	395.5

### 2 - Flow thru 24" $\phi$ Disch Pipe

Max (Inlet Contr) Discharge w/ Pond Elev. @ 396

$$HW/D = \frac{396 - 387.6}{2} = 4.2 ; \text{Max } Q = 42 \text{ cfs}$$

Since 24"  $\phi$  Pipe Max Flow is insignificant & since it might be shut during storm, ignore this pipe in following calculations.

(VI) Cont.

(B) Tailwater Levels - at High Flows ( $Q = 2200$  cfs)

When Flow Passes over Dam Crest it will fill Middle Pond & Pass over highway just down stream.

Dam Crest Flow 1500 cfs

Highway is  $\pm 300$  feet long in area affected.

Assume 54" Culvert Carries 200 cfs.

Flow/ft over highway -

$$q = \frac{1500 - 200}{300} = 4.333 \text{ cfs/ft.}$$

$$H = \left( \frac{4.333}{2.55} \right)^{0.467} = 1.42'$$

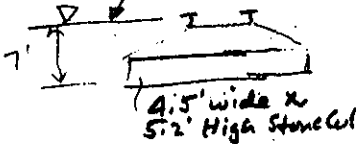
Water in "Middle" Pond @  $393.5 + 1.4 = 394.9'$

This is roughly 1.5' below dam crest.

(C) Peak Flow Thru R.R. Embankment

With Entrance Control

El. 396 $\pm$



Using V.T.C. - "Open Chan. Flow" pg 498

$$H/d = \frac{7}{5.2} = 1.35, \quad q = 50 \text{ cfs/ft width}$$

$$\therefore Q = 225 \text{ cfs.}$$

(R.R. Has not been known to overtop)

(D) W.S. Elev. due to R.R. Embankment Control @  $Q = 225$  cfs max

Flow thru outlet pipe = 42 cfs

$\therefore$  Flow out of spillway = 183 cfs

Elev. W.S. @ Dam = 395.5'

APPENDIX E  
INVENTORY FORMS